TROPICAL AGRICULTURE

THE OFFICIAL JOURNAL OF THE
IMPERIAL COLLEGE OF TROPICAL AGRICULTURE

VOL. VIII No. 10. OCTOBER, 1931. PRICE 6d.

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THE IMPERIAL COLLEGE OF TROPICAL AGRICULTURE, TRINIDAD, B.W.I.

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INDUSTRIAL RESEARCH.

Industrial Research and the Sugar Cane Industry.

OUR attention has recently been drawn to an article in the *International Sugar Journal*,* where Mr. E. L. Symes, has emphasized the necessity for providing facilities for industrial research in the sugar cane industry. Although, in the past decade, large funds have been secured for studying research problems in connection with the agricultural and factory aspects of the industry, practically no advance has been made, during the same period, in the phase of industrial research. This lack of progress is mainly to be attributed to the failure by large factory interests to include appropriations for the conduct of such research which, as Mr. Symes claims, would have served as an insurance to provide new demands and hitherto unexploited markets for sugar by-products. With sugar prices at their present level, there is an urgent need for making further enquiries into the possibilities of already well-known sugar and cane by-products, and for discovering, if possible, new by-products which would find ready sale in world markets. In this connection, a step in the right direction has already been taken at the recent Imperial Sugar Conference, when it was recommended that more attention might profitably be paid to the utilization of sugar and cane by-products, and that an authoritative survey of the subject should be undertaken.

The two main by-products of sugar cane are megass or bagasse, which is the fibrous portion of the cane, left after extraction of the juice, and molasses which represent all the sugars present in the cane which cannot be obtained in crystallized form. While megass has always been regarded as an important source of fuel and molasses is used in large quantities for the manufacture of rum, recent developments have shown that both these by-products can be utilised for many other purposes.

Megass, for instance, has already been used for the manufacture of paper, but the processes in vogue have not been entirely satisfactory, the chief obstacle for the production of a first class quality paper being the presence of a pithy element in megass which is difficult to extract. Moreover, without taking any other facts into consideration, megass is difficult to store owing to its rapid deterioration. Suggestions have been made that the pulp necessary for paper making might be obtained by a fractional digestion process which has already been applied to

* E. L. Symes. Industrial Research as applied to cane and sugar. *Int. Sugar Jnl.*, Vol. XXXIII, No. 392.

bamboos or a chlorination process used in making straw pulp. For the past ten years, megass has been used for the manufacture of a fibre board which, in the market, is known as Celotex. This material is light, but strong, has excellent sound-proofing and heat-insulating properties and finds many applications in building construction and industrial use. Other developments of the Celotex Company are a hard panel board capable of taking a high polish, wrapping paper, corrugated cardboards and also a laminated product impregnated with resin. A similar type of board is being manufactured by the Vazcane process which effects considerable economy in plant, by combining the sugar extraction and pulp producing stages, and so avoids duplication of machinery. It may be mentioned here that in Jamaica a scheme for the erection of the Vazcane process on the Serge Island is now well advanced. Megass may yet prove a useful raw material for artificial silk whilst in its finer form it has been used in some cattle foods such as "molascuits" or as flour, in the manufacture of explosives. It has been demonstrated in Cuba that high grade alpha cellulose can be obtained from cane fibre and various manufacturers in the United States have made rayon, smokeless powder and cellulose lacquers from this Cuban material.

Molasses is another by-product of sugar cane for which many industrial applications have been found. It is the cheapest raw material for the production of industrial alcohol, and has been used in this form in Natal, South Africa, Queensland, Brazil, Mauritius and Uganda. It can also be converted into glycerine, acetaldehyde or ether. The carbon dioxide produced during the fermentation of molasses has been used very profitably in the manufacture of "dry ice" or solid carbon dioxide. This is a new and valuable refrigerant which has already found many uses especially in the cold storage transport, on railways or ships, of perishable agricultural products. In America, molasses is used for the production of yeast, either for fermentation and bread manufacture or for human consumption and cattle fodder. Distillery slop can be converted by Porion's open flame oven into high grade potash fertilizers.

More recently, a new process has been developed by which solid and plastic substances can be made by polymerising sucrose, and results of this work indicate that a great variety of new products may soon be available from this source. Variations in the treatment of the sucrose containing material, which may be refined sugar or molasses, produce different end products. Treated in one way it freezes into a substance which may be used as a non-shatterable glass substitute and which may be cut into any shape with a sharp knife in the production of lenses and other useful articles. Another variation in the process will produce a water-white transparent rubber-like substance suitable for artificial leather and kindred work. It is also possible to produce a celluloid substitute which is said to be whiter, more brilliant and non-inflammable. When powdered and pressed in a hot mould it can be used as electrical insulators or with the addition of colouring matters, for making trinket boxes or pearl buttons. Some of the other uses contemplated are wall hangings, adhesives, textiles, photographic films, transparent wrapping sheets, roofing tiles, paints and varnishes. The new material may be produced at about $4\frac{3}{4}d.$ per lb. which is well under the current prices for standard plastics. The cost can be further lowered by manufacturing it in sugar producing countries. If the claims for this new process and its products are not overstated, it may offer an outlet for large quantities of surplus sugar that is now embarassing the sugar world.

It will be obvious from this brief review that industrial research in the sugar cane industry offers very wide possibilities. Except for isolated efforts the use of sugar for purposes other than consumption appears hitherto to have escaped the close attention of the sugar world. The remedy should lie in the stimulation of interest in organized industrial research.

A ZOOLOGICAL EXPEDITION.

FOR the past two months the College has been the headquarters of an expedition sent out to Trinidad early in July by the Philadelphia Academy of Natural Sciences for the purpose of collecting birds and other Zoological specimens. The members of the expedition, who left on 6th September, were Mr. H. Radclyffe Roberts, of the University of Pennsylvania; Mr. George R. Clark, of Harvard University; and Mr. W. Wedgwood Bowen, Assistant Curator of birds in the Academy's Museum. The Biological Laboratory of the College was placed at the disposal of the party and used as a base during six weeks of the time, the remaining two weeks being spent at Brighton, where accommodation was provided by the Trinidad Lake Asphalt Operating Company. From these two bases excursions were made by car to various parts of the Colony. Five East Indian boys were trained to assist in the work of skinning and preparing the specimens.

Several ornithologists have collected birds in Trinidad in the past, and it is not expected that any novelties will be discovered by the present expedition whose chief object was to fill in a gap in the Academy's study collection of the birds of the world. However, a comparison of notes made by this expedition with those made by previous collectors ought to throw light upon the effect of changes due to agricultural and commercial development upon the bird population of the island. Mr. F. W. Urich has agreed to co-operate with the Philadelphia Academy in an investigation of the stomach contents of the birds collected, and much information of economic importance should result. About 740 specimens of birds, representing about 160 species, were obtained. Exact determination of these will not, of course, be possible until the collection has been studied in Philadelphia.

WASTAGE IN BANANA TRANSPORT.

Wastage in the Refrigerated Transport of Canary Bananas from South America to Europe.

By R. G. Tomkins.

(*Low Temperature Research Station, Cambridge.*)

I. Introduction.

In the summer of 1928 and during the whole of the following year an examination was made of the wastage in the transport of bananas from Brazil to England. A report containing an account of these observations, together with certain recommendations was written in October, 1929, but it has not been published. Since then a report "The Behaviour and Diseases of the Banana in Storage and Transport" has been prepared by Drs. Wardlaw and McGuire and has been published under the auspices of the Empire Marketing Board. This report deals with many of the problems discussed in the unpublished report. In some respects, the wastage in Brazilian bananas differs from that encountered in the trade in the West Indian Gros Michel bananas. But in general the conclusions reached in the work on wastage in Brazil bananas are in agreement with those expressed by Drs. Wardlaw and McGuire. It is, of course, impossible in England to do extensive experimental work on problems of banana wastage. The following account (essentially the contents of the 1929 unpublished report) will serve, however, to emphasise not only the need of such work but also the value and importance of carrying it out in Trinidad.

For some years British enterprise has been endeavouring to develop a trade in bananas from Brazil to London. The attempt constitutes a definite extension of what has previously been considered feasible in the long distance transport of this tropical fruit.

Shipment from South America and the West Indies requires a sea passage of some 17 days, and necessitates the use of refrigeration and close packing in the holds for freight economy. The Canary or Cavendish banana has in the past always been thought to be too tender a fruit to tolerate these conditions, and the West Indian trade at present is almost entirely a trade in the Gros Michel banana, a larger, tougher and coarser variety.

The trade in Cavendish bananas from Brazil is at present on the basis of one or two full shipments a week throughout the year but it is suffering from the fact that extensive wastage of the fruit occurs both in transport and in the ripening rooms.

The information contained in this paper has been derived from observations made at the port of arrivals and at the ripening rooms and from experimental work at the Low Temperature Research Station. In addition, the trade have allowed access to their records and contributed all information in their possession including that relating to pre-shipping conditions and conditions during the voyage.

II.—Methods of Transport.

Type of Banana.

The type of banana that is being shipped from Brazil, is claimed to be a Canary (Cavendish). Though the lower hands of a bunch cannot be distinguished in shape, colour or flavour from the real Canary banana yet the upper hands of the bunch are larger in size and resemble more nearly in shape the Jamaican (Gros Michel) type.

It would seem desirable to determine exactly what varieties are being shipped from Santos. We have information from Kew that they have recently obtained two suckers from Brazil. One of these was called "Ananica" and was a true Cavendish and the other, "Mestezas", as far as could be told, was a semi-dwarf variety but not a true Cavendish.

Production.

Production is not solely for the English market as bananas from this region are also exported to the Plate River. For the English market, fruit of a selected class or grade only is shipped.

The fruit is gathered at the "three-quarter" fulness stage of maturity. It is cut a few days before the boat is due and is wrapped in thick paper bags at the time of cutting. The bunches are carried down to the loading stages in open barges and are then often exposed to very heavy rain which, it is said, sometimes collects in the bottom of the barges in considerable quantities.

Loading the ship takes from 24 to 48 hours and is not suspended on account of rain.

Conditions on Shipboard.

The methods used in carrying bananas from South America to Europe are, with one exception, similar to those used in the carriage of bananas from Jamaica; each bunch of bananas is wrapped in a paper bag to reduce the amount of damage from bruising. The holds are provided with false slatted floors, and are divided into "bins" into which the fruit is stacked three tiers deep.

The cooling is carried out by continuous air circulation. The air is drawn from the hold through a large trunkway, is carried over the brine grids and is re-delivered to the holds through a series of ports arranged at various heights in all the side walls. The temperature of carriage varies from 52° to 56° and is said to be reached after three days. At the time of arrival in England the temperature throughout the hold is fairly uniform but how quickly uniformity is attained is not known.

"Chilling" occurs not infrequently but is always attributed, at least by the ship's engineers, to low night temperatures experienced on the plantations.

Ripening.

The methods employed in ripening bananas from Brazil are similar to those employed in ripening Gros Michel bananas from the West Indies. The bunches are suspended from the

ceilings of the ripening rooms which can be warmed to a suitable temperature by naked gas flames. Normally the rooms are kept at a temperature of 68° F., but lower temperatures may be employed if it is desirable to delay ripening. The average time taken for ripening is about six to eight days. The relation between the rate of ripening and temperature can be seen in Table I.

Table I.

Temperature and the Rate of Ripening of Bananas after Transport. Number of days required for green Bananas to become yellow.

	F	56°	59°	65.5°	72.5°	
	C	13.5°	15°	18°	22.5°	
Detached Bananas		19.5	11.8	9.6	6.6	days.
Bananas in hand		17	14	7	6	do.
Bananas in hand		24	18	12	6	do.
Bananas in hand		17	14			
Average		19.4	14.4	9.5	6.2	

There is a belief "in the trade" that high humidities tend to hasten ripening, and "difficult" bunches are often collected together in a ripening room and water sprayed liberally on the floor.

It has been possible recently to test the effect of humidity on the rate of ripening of bananas. Three gastight metal tanks each large enough to hold a single bunch of bananas have been fitted with a two way pipe at the bottom and a simple exit pipe at the top. Air is drawn from the top and admitted at the bottom, dry air through one tap, wet air through another tap. By a suitable adjustment of the taps constant desired humidities may be obtained.

Four bunches of bananas (Jamaican Gros Michel bananas were used in these experiments) were obtained, each split longitudinally and then the one-quarter bunches reassembled into four comparable synthetic bunches. Three bunches were kept in the tanks and the air taps so adjusted that the air streams issued at relative humidities of 95, 80, 65 per cent. respectively. The remaining bunch was kept in the room the humidity of which was approximately 50 per cent. They were allowed to ripen and then compared. At the end of a week no difference could be detected in the conditions of the fruit. The extent of ripening was the same. No damage had been done by the low humidities. Even at the low humidities some finger rot had developed.

The experiment was repeated.

Again at no stage could differences in the rate of ripening be detected. This time, *Thielaviopsis*, very evident at 95 per cent., was not so evident in the bunch stored at 65 per cent. relative humidity and in the dry air of the room. The flavour was excellent in every case. From these experiments it is safe to assume that humidity has no effect on the rate of ripening in the later stages and that if ripening proceeds at a quicker rate in damp rooms the reason is not due to dampness alone. Whether a difference might be detected in bananas stored from the time of gathering at different humidities it is impossible to say.

III.—Wastage in Transport and in Ripening.

Types of Wastage.

There is a widespread opinion that the mass transport of the Cavendish banana is impossible and for this reason. This type of banana bruises with extreme readiness and bruising is always followed by rotting. Bruising, perhaps inevitable, is certainly a very serious problem, but its seriousness has probably been over-estimated.

Causes of wastage other than bruising will be considered here.

Stalk-rot, finger-rot (=main stalk-rot and finger stalk-rot in the Trinidad nomenclature) and "ships ripes" are considered to be the main causes of loss.

Stalk-rot is the decay of the main stalk. It affects both the large and small ends, though it is usually the large end which is most seriously rotted.

Stalk-rot is undesirable for several reasons. It is unsightly and raises prejudice against the fruit when it is sold by the bunch. It also increases the difficulty in handling both at the docks and in the ripening rooms. Rotten stalks are often not sufficiently strong to bear the weight of the bunch when hung in the ripening rooms. It is also believed to be, and sometimes is, the cause of finger-rot. The evidence for this is considered later. It may also affect the rate of ripening though for this there is no good evidence.

Finger-rot is a rotting of the stalks of individual bananas with the consequence that these bananas drop. This is the most serious cause of loss. Loose bananas can be sold if at all only at very poor prices. If dropping takes place on the boat, the greater portion is not only lost, but their presence on the decks and the labour of clearing them away materially increases the difficulties of unloading. Not only are loose bananas of little value, but the hands from which they fall are also reduced in value.

WASTAGE IN BANANA TRANSPORT.

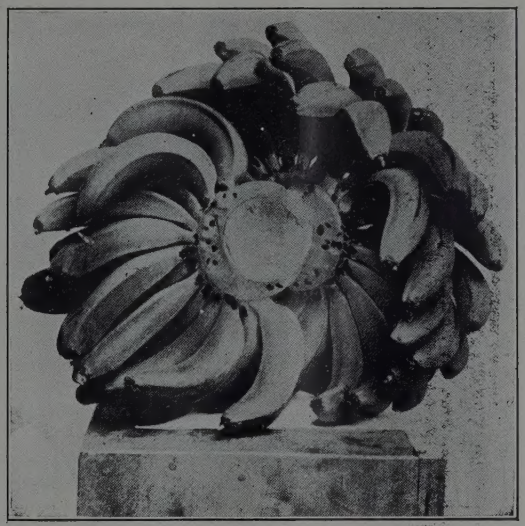

FIG. I.

Spots (marked in ink) and their position on the exposed parts of the three upper hands.

FIG. II.

2nd hand. 3. 1. 30. Spots on bananas in middle of hand. Mechanical damage to three on right.

WASTAGE IN BANANA TRANSPORT.

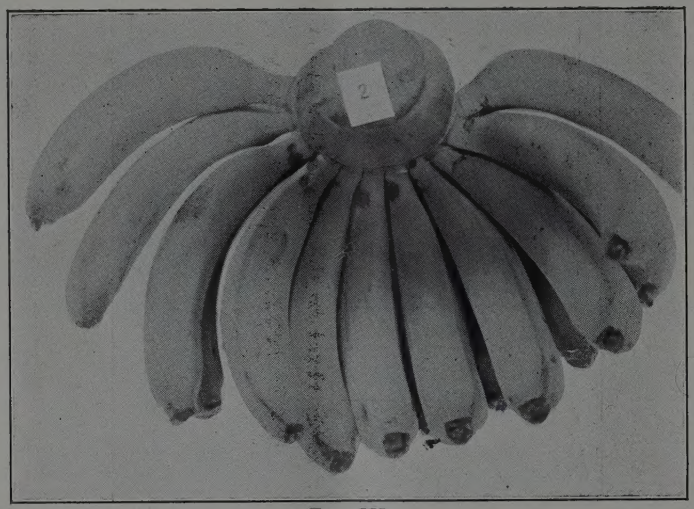

FIG. III.
Same as Fig II. 8. 1. 30. *Spots spreading. Attack through mechanical damage.*

FIG, IV.
As above. 13. 1. 30. *Spots and mechanical damage have now been followed by finger-rotting.*

"Ships Ripes" is the term used to describe those stalks of bananas which ripen in transit. Although a certain number of "ships ripes" may be of considerable value if they arrive when there happens to be a general scarcity of fruit, yet ripe bunches are usually found to be suffering from stalk-rot and finger-rot and are almost certain to receive further damage in handling. Ripe bananas are exceedingly difficult to handle. Moreover the methods of distribution have been built up on a supply of green fruit.

Extent of Wastage.

It is difficult to estimate the extent of wastage. Several methods might be adopted.

A general observation of the cargo is the method usually practised. Large numbers of loose bananas may collect in the holds. At times there are noticeably fewer than at others. The number of these might provide some indication of the general condition of the shipment. Unfortunately there are no records of the number of loose bananas collected from the ships. Though there is an agreement by which the loose bananas are sold and though records for the price paid for those sold on any ship could be obtained, this would give no indication of the actual numbers present, for the price obtained is determined by the numbers collected. When the price is low, bananas which at other seasons would be recovered, are thrown away.

It is also unfortunate that these figures are not available to provide a means of comparing the number of loose on arrival with the number of loose at the ripening rooms. The rot is presumably developing from the time of picking to the time of ripening, and therefore, the number falling at the time of unloading will depend on the rate at which the finger-rot has developed up to that stage. Other conditions being similar the extent of rot will depend on the time. Thus, cargoes which in the end may show the same total number of loose bananas may, at the time of discharge, show unequal numbers of loose owing to a difference in the time of the voyage. From a badly affected cargo a large number of loose fruits will be collected both at the docks and in the ripening rooms. A cargo free from infection should show a low percentage in both places. It should be observed that a cargo apparently free from finger-rot at the docks, often proves in the ripening rooms to be in reality quite badly infected.

Loose bananas may be sound or rotted at the fingers. The percentage number of loose bananas collected at random in the ship's hold which were rotten at the fingers were 91 in one instance, 84 in another. It is quite clear that the majority of bananas knocked off in handling are finger-rotted. To remove sound bananas in the green stage requires considerable force, and it is noticed that rough handling often removes whole (sound) hands rather than individual bananas. The finger-rotting allows very easy removal. Even if finger-rotting cannot be prevented, to delay its development until after discharge from the boat would be an advantage in so far as a large number of loose fruits at the docks make additional labour, and are for the most part wasted. If finger-rot develops in the ripening rooms the loose bananas can be more easily collected and disposed of, and also with more careful handling the bananas might remain attached.

The sales figures also provide interesting information about the condition of the fruit. The number of boxes of selected, best, second and loose fruit obtained from each shipment are recorded at the ripening rooms. These records have been examined. A very distinct seasonal drift in the numbers of loose bananas is apparent. This had passed unobserved in eye inspections at the docks. Indeed from what has been said above it may not have been present.

Stalk Rot.

Fungi Associated with Stalk Rot.

The fungi associated with rotten stalks have been isolated and many distinct species found to be present.

Gloeosporium musarum and *Fusarium* spp. invariably occur, but it cannot be said which of these causes most damage. All moulds growing saprophytically on the stalk will assist in breaking down the tissues and so aid in producing a rotten condition. Another commonly occurring fungus is *Nigrospora oryzae. Rhizopus nigricans*, *Penicillium* spp., yeasts and bacteria are invariably present if rotting is in at all an advanced stage.

The most interesting fact is the apparently almost complete absence of *Thielaviopsis paradoxa*, the cause of the very serious stalk-rot of Jamaican bananas. Damage due to this fungus has not been observed in the ripening rooms.

Though numerous isolations have been made only on one occasion has it been found to be present.

Brazilian pineapples suffer very badly from the attacks of the fungus, but it is not possible to say whether Brazilian bananas are more resistant to the attacks of this fungus than the West Indian Gros Michel or whether it is a trouble which at any moment may suddenly appear.

Extent of Stalk-Rotting on Arrival.

The extent to which any stalk may be rotted varies enormously. Few stalks are entirely unattacked. Some are completely rotten down to the first hand and to an extent of about 12 inches. The majority are rotted to the extent of three to four inches.

Relation of Stalk-Rot to Rotting of the Fingers.

Extensive rotting of stalks is generally accompanied by extensive rotting of the "fingers" of the bananas of the two uppermost hands. In such instances the rotten condition of the fingers may well have been produced by spread of fungi from the rotting stalk. In fact, it has been possible experimentally to produce rotting of the fingers by the inoculation of the main stalk with *Gloeosporium musarum* and *Fusarium* spp.

Rotting of the fingers produced in this way is found to affect every banana on the hand. A diffuse browning of the fingers is first seen. The colour becomes darker and the tissues of the finger softer. There is no localised browning on either surface of the finger. Further the hands nearest such a source of infection are attacked before those further away. Thus stalk-rot, may, by spreading, produce a rotting of the fingers and dropping of fruit. It is in this way that *Thielaviopsis paradoxa*, first attacking the stalk, spreads into the finger stalks and bananas and causes the type of wastage so often met with in Jamaican bananas. But it can be confidently stated that rotting of fingers, in bananas from Brazil, due to an infection from a rotting stem is not so frequent as finger-rotting due originally to "spotting" or mechanical damage.

Relation of Rate of Advance to Temperature.

The rate of increase in the amount of stalk which is rotted will be determined by the rate at which the moulds grow down the stem from the point of attack. Temperature which markedly influences the rate of mould growth should therefore have a marked effect on the development of stalk-rot. The effect of temperature on the rate of growth of two of the fungi most frequently found is shown in Table II.

Table II.

Effect of Temperature upon Relative Rate of Growth of Fungi associated with Stalk-Rot when grown on Culture Media in the Laboratory.

Temperature	F	77°	72.5°	65.5°	59°	56.5°	50°
	C	25°	22.5°	18.5°	15°	13.5°	10°
Fusarium		3.6	..	2.8	2.2	1.4	1
Gloeosporium		4.1	3.3	2.7	2.0	1.3	1

Stalks have also been inoculated and the rate of advance of the rot has been measured. The effect of temperature is shown in Table III and in Diagram I.

Table III.

The Extent of Rotting measured in Centimetres following the Inoculation of Stalks with (a) Gloeosporium musarum and (b) Fusarium sp.

Temperature	F	50°	56°	59°	65.5°	72.5°
	C	10°	13.5°	15°	18.5°	22.5°
(a) *Gloeosporium musarum* After 10 days ..		0	.4	1.08	1.8	1.1
After 19 days ..		1.4	2.7	4.2	7.6	10.2
(b) *Fusarium* sp. After 10 days ..		0	.1	.2	.95	1.0
After 19 days ..		1.2	2.6	2.2	6.5	7.0

At 56.5°F. that is, at the temperature of the hold, only about one inch of stalk was rotted in 19 days. This is far less than the extent of rotting that is actually found to have taken place and some explanation for this is needed.

The experiments appear to provide one. It will be noticed that the length of stalk rotted in the first ten days after inoculation is trifling as compared with that in the second ten days. The actual relation indicated is about 1 to 4. It will also be noticed that the amount of stem rotted in a given time at 56.5°F., the temperature of carriage and 72.5°F. an average pre-shipment temperature is as about 1 to 3. What probably occurs, therefore, is that infection occurs directly after cutting. The two or three days following at a high temperature, correspond to six or nine days at 56°F. While the fungus is establishing itself in the stalk, progress up the length of stalk is insignificant. The bunches now go into the holds and the fungus starts to rot the stem immediately at the more rapid rate found in the second ten days in the experiments quoted above. If this is so then we should expect not one inch of rot on arrival but on the average three or four inches, as is found.

The importance of the above considerations lies in the conclusion to be drawn that trimming the stems immediately before placing in the hold would reduce stem rotting to about one quarter of its present dimensions.

The Control of Stalk-Rot.

The control of stalk-rot is a subject which, because of the enormous wastage encountered at certain times in the trade in West Indian bananas, has recently received much attention.

It now seems certain that stem rot can be overcome provided certain precautions are taken.

First, just before shipment, all infection—and at the temperature and in the conditions encountered on transport from plantation to

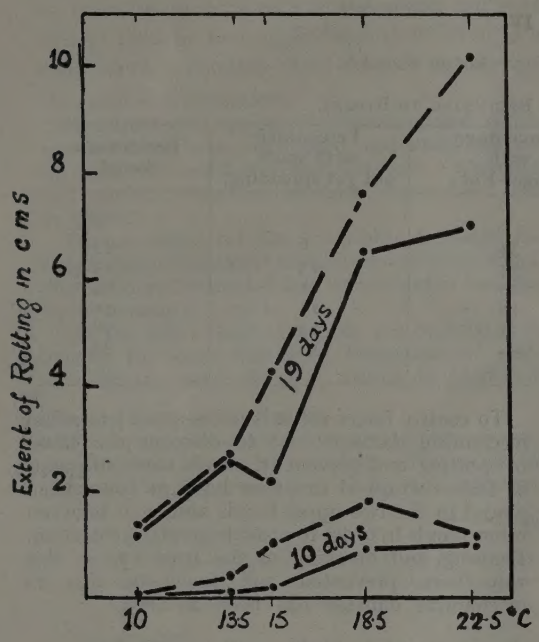

DIAGRAM I.—*Relation between temperature and amount of stalk-rotting produced by*
(*i*) *Gloeosporium musarum* - - - - -
(*ii*) *Fusarium sp.* ————

docks, infection is almost certain—of the stem must be removed by recutting with a knife. If this is not done the further progress is rapid. If all infection is removed then rotting can only follow after infection has been re-established—a process long delayed at low temperatures.

Second, the cut may with advantage be treated with vaseline or some other wax mixture which makes good contact and does not crack. Other types of wound treatment, such as the use of fungicides, have been tried but found with a few possible exceptions to be useless (1). The method of preventing entry by some purely mechanical means (for the action of vaseline is considered mechanical (2)), alone seems to offer hope of effective control.

The results of the large scale experiments on the commercial possibilities of the vaseline—the real test of the treatment—being undertaken by Drs. Wardlaw and McGuire will be awaited with interest.

FINGER-ROT.

Bunches are best examined for finger-rot in the ripening rooms by suspending them by the big end of the stalk, so allowing them to hang in the same way as in the plantation. In this position the upper surface of the hands on which attack most frequently takes place can be observed.

(1) Tomkins, R. G. and Woodman, R. M. Stalk Treatment of Fruit and Vegetables, &c. *J. Soc. Chem. Ind.*, London, 1930, XLIX, 285.
(2) Tomkins, R. G. Vaseline and Growths of Mould. *Report, Food Investigation Board*, 1930, p. 68.

Three causes of finger-rot can readily be recognised.

"Spots", which can readily be recognised as points of fungal infection with strictly limited invasion areas, may develop to give finger-rot.

Mechanical damage due to handling is frequent. This is due in part to the rather spreading hands and the proverbial delicateness of the Canary banana and in part to the methods of handling. Such damage is invariably followed by rotting. Bananas damaged at loading are usually rotted by the time of discharge. Bananas damaged at discharge usually rot before ripening.

There is also the type of finger-rot which may result from spread from a rotten stem and which has already been mentioned.

Observations of cargoes during discharge indicate a large class of cases of advanced finger rotting and a large class of spotted bananas which will develop finger-rot in ten days or so during ripening. The majority of cases of advanced finger-rotting on discharge originate from infections following preshipment mechanical damage.

Position of Damaged and Spotted Hands on the Stalk.

Finger-rot is found chiefly on the two upper (large) hands and decreases on passing down the stem.

The upper two hands are those most readily damaged in handling. The middle bunches are supported behind and before by other bunches. The two uppermost bunches are not protected on the concave side. In this position their lack of support allows them to be bent up towards the stem. The bananas themselves and the main stalks being relatively rigid the whole of the bending occurs at the narrow base of the banana where it joins the main stem. Injection of intercellular spaces can be seen to occur with the naked eye. In effect what happens is a severe localised bruising.

Spotting appears chiefly on the two top hands and that part of the third which is not directly beneath the two top ones. These are the only hands not overlapped by other hands. It is only on those exposed parts that spotting is noticeably found. This is shown in Figure I. Table IV shows the distribution of finger-rots on the various hands of 28 bunches of bananas which were not noticeably damaged through bad handling but which showed extensive spotting. Finger rotting is observed to be most extensive in the upper (large) hands.

Spotting occurs in bunches in which the possibility of mechanical damage before shipment can be eliminated owing to special precautions in packing and padding. It therefore seems most probably to originate in the plantations and to be related to exposure.

Development of Finger-Rot in the Ripening Rooms.

The amount of finger-rotting increases with ripening. The mode of development of finger-rot can therefore be followed by recording the conditions of bunches at the time of their being placed in the ripening rooms and at subsequent

Table IV.

The Distribution of Finger-Rot on Bunches.

(Data from 28 Bunches Beginning to Ripen).

	Total Number of Bananas.	Percentage with Finger-Rot.	Percentage with spots not yet spreading.	Percentage Sound.
Top hands	375	54	6	39
2nd do.	341	34	13	53
3rd do.	272	25	11	64
4th do.	250	18	11	71
5th do.	241	11	12	78
6th do.	175	—	12	88

regular intervals. Table V is included as an example of one such series of examinations. From such examinations as these the following conclusions may be drawn :—

(1) Mechanically damaged fingers invariably become rotted.

(2) Spots on otherwise sound bananas increase in size and cause finger-rotting. This is shown in Figs. 2, 3, and 4.

(3) That a rot may spread from one finger to the adjoining and formerly sound fruit. This may be termed spread by contact.

(4) Fresh spots have not been observed to arise in the ripening rooms.

(5) Hands which are free from mechanical damage and also free from spots ripen into perfectly sound bananas, unless infection comes from the main stalk.

Finger-rotting is thus seen primarily to occur :

(1) in hands mechanically damaged ;

(2) in hands which are not damaged but are spotted ;

It may also occur :

(3) by contact infection ; or

(4) by spread of rot from the stalk.

Table V.

An Example of the type of Data obtained as regards the development of Finger-Rot from Spots in the Ripening Rooms.

Date of Examination.	First Hand.	Second Hand.
18. 9. 29 ..	Bananas Nos. 2, 3, 5, 6, 7, 8 with spot. Nos. 1, 4 sound.	All sound.
23. 9. 29 ..	Spots spreading.	All sound.
26. 9. 29 ..	Nos. 2, 3, 5, 6, 7 finger-rot. No. 8 spot. Nos. 1, 4 still sound.	All sound.

Thirty other bunches were kept under observation at different times and gave similar results except that the second and third hands were often also affected.

To control finger-rot it is necessary (1) to avoid mechanical damage ; (2) to discover the cause of spotting and prevent it. Pads made of paper or leaves wrapped in paper have at times been placed in the two upper hands and even between other hands in order to provide greater protection. Bruising and breaking of the fruit has in this way been prevented and finger-rot due to mechanical damage has been avoided.

Fungi associated with Finger-Rot and Spotting.

The fungi found most frequently to be associated with vigorously developing finger-rots are *Gloeosporium musarum* and *Fusarium* sp. Occasionally, there are also present, *Nigrospora oryzae* and bacteria.

The fungus associated with "spots", especially before they have begun to show any increase in size, is an entirely different one, namely a *Pestalozzia* sp.

The following Table VI records the numbers of isolations made and shows *Pestalozzia* to be present in 86 per cent. of spots examined. In the remainder one or other of the fungi mentioned above was found to be present.

Table VI.

No. of isolations.	No. with Pestalozzia.	No. with fungi other than Pestalozzia.
42	39	5
27	26	3
33	30	5
56	44	9
21	16	6
Total 179	155 (86%)	28

When, however, isolations were made from "spots" which were increasing in size, *Gloeosporium* and *Fusarium* were found to be present.

The *Pestalozzia* sp. when grown on malt agar produces a greyish-white mycelium but only a few spores and these, rather abnormal, vacuolated and irregular in outline. On Dox's agar it has occasionally produced abundant spores normal in appearance with the following characteristics :

Conidia elliptic, five (or six) celled, the three (or four) central cells dark, the end cells hyaline, 22 to 28 to 36 × 7 to 8 μ, the apical cell with two to three or four appendages 16 to 20 to 24 μ long, basal appendage short four to six μ.

Inoculation Experiments.

Mycelium and spores of *Fusarium* and *Gloeosporium* have been introduced into small wounds on otherwise sound, sterilized bananas. Wounded and surface sterilized bananas, have been left as controls.

Typical finger-rot has invariably followed the inoculation of bananas with either of these fungi. Sterilized and wounded but uninoculated bananas have remained sound.

On the other hand if fingers are inoculated in exactly the same way with *Pestalozzia* sp. none or only the very slightest rotting is produced.

Mode of Entry of the Fungus.

The entry of *Gloeosporium* and *Fusarium* into the finger is followed by rotting. The modes of entry so far mentioned are (1) through fractured tissue, (2) from the main stalk (or from a neighbouring banana or collar). A third method, through "spots", will be mentioned later. Spores of *Gloeosporium musarum* placed on sound fingers have been observed on one occasion to penetrate after some delay the tissues of ripe bananas and cause finger-rot. There is no evidence as to the extent to which this type of infection takes place under transport and ripening conditions but it is thought to be of infrequent occurrence.

The rate of rotting after inspection depends on the rate of growth of the fungus within the tissues and is to some extent determined by external factors.

Relation of the Rate of Spread of Finger-Rot to Temperature and Humidity.

(*a*) *Temperature.*

The rate of growth of *Gloeosporium* and *Fusarium* with temperature is shown in Table II.

The rate of spread of finger-rot with temperature is shown in Table VII.

Table VII.

Approximate number of Days for Finger-Rot to develop in Sound and in Bruised Tissue.

Temperature		F	56°	59°	65.5°	72.5°
		C	13.5°	15°	18.5°	22.5°
Gloeosporium musarum	In sound tissue		24	15	12	8
	In bruised tissue		23	15	12	8
Fusarium	In sound tissue		28	20	14	8
	In bruised tissue		27	19	13	8

As in the case of stalk-rot it will be noted what a marked difference there is in the time taken for finger-rot to develop between 56°F. and 59°F. Also it appears that at the hold temperatures finger-rot takes 24 to 48 days to develop from the time of inoculation, so that again there is evidence of some fungal progress before shipment.

(*b*) *External Humidity.*

If the mycelium is introduced into the tissues no effect of the external humidity on the rate of spread can be observed except when the humidity is so low that damage is caused by pronounced wilting.

The production of external mycelium certainly varies with the external humidity. At high humidities the mycelium readily grows from the surface of rotten fingers and allows spreading of the disease by contract.

How far total wastage is influenced by the external humidity is not known.

Reasons have recently been advanced Tomkins (1) for believing that by maintaining low humidities it would be possible to effect some, though not extensive, reductions in wastage of fruit in storage due to fungal rotting. In reference to this, the experience of a banana importer in Stockholm is of interest. He has found it profitable to maintain a low relative humidity in the ripening and storage rooms by circulating the air over the cooling apparatus (and so drying it) and reheating it again to the required temperature by gas flames in the room. Excessive wastage from rotting was said in this way to be avoided.

Ripeness.

Two methods have been used to investigate the effect of ripeness on attack. The first method is this.

Two similar samples have been stored for some time, one at 18.5°C., the other at 13.5°C. They have then been taken and inoculated and stored at the same temperature and the rate of spread of finger-rot has been observed.

In a second method the bananas of the same hand have been inoculated at different times and the rate of spread observed.

So far these experiments have shown no marked difference in the rate of attack of bananas of different degrees of ripeness. This may be

(1) Tomkins, R. G. Biological Effects of Humidity in the Storage of Fruit. *Proceedings, First Imp. Horticultural Conference*, 1930, Part III.

due merely to the slight differences in degrees of ripeness which it is possible to obtain by the methods adopted.

Bruising of the Tissue.

Table VII shows the rate of spread from a clean wound and from a wound in tissue which has been bruised. The rate of spread is slightly greater in bruised tissue.

Origin of Spotting.

It cannot be said from examination of the bunches in England how, or when "spotting" originates, but because of its appearance and because of its peculiar distribution it is believed to be of plantation origin. The fact that *Pestalozzia* does not, by inoculation, cause a finger-rotting of bananas as mature as those arriving in England, also suggests that attack is limited to some early stage of development.

From the position of "spotting" on certain hands, and from the fact that some bunches are completely free from spots while other bunches gathered at the same time from the same locality are not, it is suggested (tentatively for there is no evidence and the writer claims no knowledge of bananas in culture) that the incidence of "spotting" is in part at least influenced by the position of the large flower bract. Its normal position might protect the three upper hands, its removal permit exposure which is followed by attack.

However, only investigation in the field can lead to the discovery of the stage of development of the fruit and the other factors allowing initiation of spotting. Only then too, can measures, mechanical protection or the use of sprays, be designed to prevent its occurrence.

The Spreading of Spots.

Spots have been observed to spread and form finger-rot, but *Pestalozzia*, the fungus found associated with non-spreading spots has not however been found in inoculation experiments to cause rotting.

On the other hand *Gloeosporium* and *Fusarium* which will cause rotting are found associated with spots actively developing.

The origin of finger-rot from spotting therefore appears to be after this manner.

Spots allow the entry of *Gloeosporium* and *Fusarium* and in this respect resemble mechanically damaged tissue. However, entry through spots is not quite so ready as through ordinarily damaged tissue, for the rate of spread from damaged tissue has often been observed to be more rapid than spread from spots. Also some spots never develop to give finger-rot.

The Prevention of the Spread of Spots. Temperature.

During carriage the spots spread but slightly, (the finger-rotting which is present at time of unloading the holds is at present believed to have originated mainly from mechanical preshipment damage.) This failure to spread may be due to the unripe condition of the bananas and the low temperature. Therefore the conditions most likely to reduce spread of spots to a minimum would be a minimum temperature and minimum rate of ripening during shipment and then a maximum rate of ripening on discharge.

These are conditions which for other reasons are to be desired and which it is usual in practice to try to obtain. How far they are really obtained is a matter of question and attention should be given to this point.

Application of Fungicides.

Fungicides have been applied to the spotted hands of bananas at the time of their being placed in the ripening rooms. No control however has been obtained in this way.

In case of attack through mechanically damaged fingers some slight delay has been observed.

Seasonal Variation in Amount of Finger-Rot.

Finger-rot is the chief cause of dropping of bananas. The number of loose bananas collected from any sample may therefore be taken as an approximate measure of the amount of finger-rot. The percentage number of loose bananas per shipment which have been collected in the ripening rooms have been plotted in (Diagram II).

A well marked seasonal variation is seen. The maximum numbers are found in December. There is a steady decrease to a minimum in June. From June to December there is a steady rise.

There appears to be a marked correlation of the number of loose bananas with the season drift of temperature. To a less extent finger-rot also fluctuates with rainfall. This seasonal fluctuation in the amount of finger-rot may be due to any or all of the following reasons.

(1) Owing to climatic conditions the fruit available for transport from November till March is "fuller" than fruit available from March till November. It may therefore be more liable to mechanical injury.

(2) The increased temperature and rainfall may favour the attack by the fungus and result in the initiation of more spotting in the plantation.

(3) The increased rate of ripening due to a high temperature between cutting and loading and a higher average temperature of carriage due to high loading temperatures may result in greater numbers of "ships ripes" and hence more damage and more finger-rot.

Ships Ripes.

The time taken for bananas to ripen after they are cut depends primarily on the fullness of the bunch at the time of cutting and the temperature at which it is stored.

Given even temperature conditions, those bunches which were most mature at the time of cutting will ripen first. Bunches of "full" bananas are those most likely to ripen on board. Table VIII gives the relative proportions of "full", "three-quarter" and thin bananas sound on one boat and the numbers of "green", "turning", "yellow" in each of these classes. Whereas all the "full" bunches were "yellow" or "turning", the "thin" bunches were all green.

Table VIII.

The relation between Ripeness and Fullness of Bunches in a Sample of 79 chosen at random on boat and classified according to Fullness and Ripeness.

	Full.	Three Quarters.	Thin.
	%	%	%
Green ..	0	37	21
Turning ..	8	27	0
Yellow ..	4	4	0

Given uneven conditions of temperature those bunches subjected to the highest average temperatures ripen first. No particular distribution of ripe bunches throughout the hold has been noticed and this indicates that proper maturity is more important than temperatures of carriage in avoiding "ships ripes" under present conditions.

The rate of ripening of green bananas after arrival in this country is shown in Table I. Ripening increases rapidly as the temperature is raised above 55 °C. As the success of transport depends on maintaining the bananas in a green condition it is necessary that the temperature be kept not higher than 55 °F. Further, this temperature must be attained as soon as possible.

Ripe bananas are not only more liable to mechanical damage than green bananas, but they apparently allow a more ready spread of rotting in damaged fingers. The number of loose bananas collected from ship-ripe bunches is usually greater than from ordinary green fruit.

IV. Wastage Reduction.

It now remains to be considered how transport conditions can be modified to allow more successful carriage.

First, there is the question of temperature relations. On principle the present methods seem adequate. The temperature is reduced to 55 °F-53 °F. and at this temperature ripening is very considerably delayed and there should be no low temperature injury to the fruit.

It cannot be said however that we have yet any precise knowledge based on experiments as to the exact limit of chilling injury either as regards temperature of time of exposure; or as to how this limit may be affected by the stage of ripeness or fullness of the fruit, &c. Such knowledge will shortly be forthcoming from the Low Temperature Experiment Station in Trinidad (1).

The fruit is loaded at a temperature often considerably higher than that to which it is to be cooled on the boat. How soon the carrying temperature is attained on the boat is not known. The time taken would appear to vary considerably. The carrying temperature is stated to be attained in from two to four days. It is doubtful however if even in this time the cooling of the fruit is as far advanced as the cooling of the air.

(1) Wardlaw, C. W. and McGuire, L. P. "The Behaviour and Diseases of the Banana in Storage and Transport with special Reference to Chilling." *Tropical Agriculture*, Vol. VIII, No. 6. [Ed.]

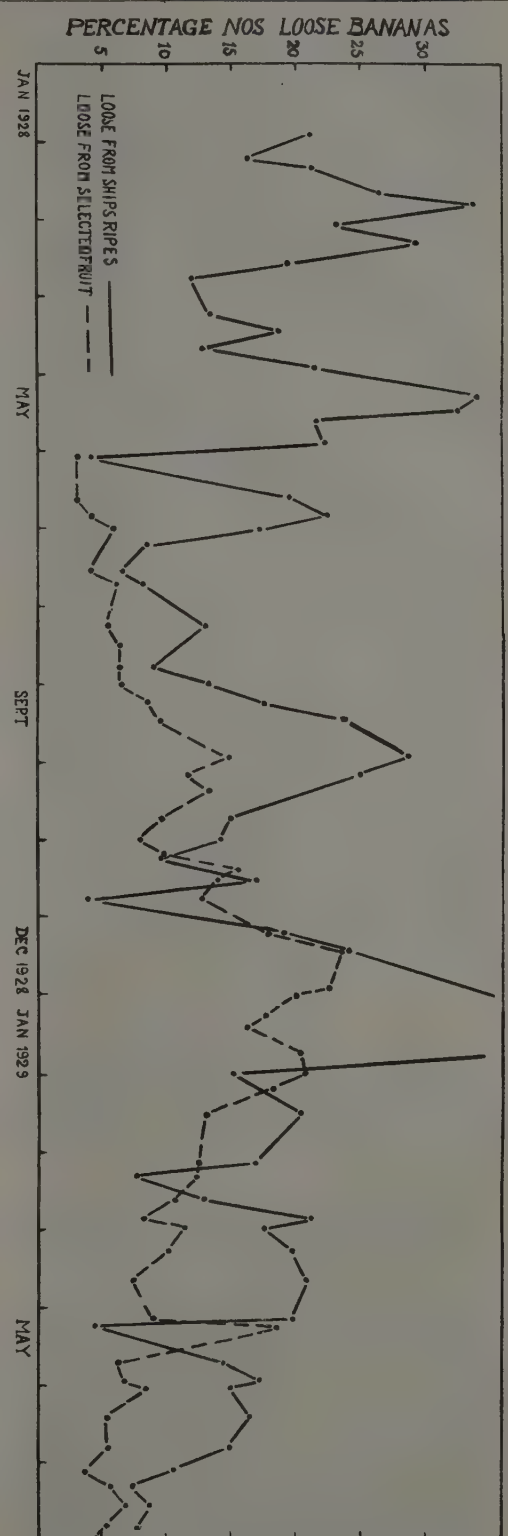

DIAGRAM II.—*The percentage numbers of loose bananas in shipments of bananas.*

During the preshipment period and during the cooling on board, ripening and fungal invasion proceed as a function of the temperature, while fungal invasions are probably much increased by humid conditions both before shipment and on board. Fungal infections once established continue to develop even at the low temperature of carriage eventually established. These are the reasons for shortening the preshipment period as much as possible by punctuality and organisation and for concentrating on attaining the maximum rate of cooling when once the fruit is on board.

The range of temperature in different parts of the hold when a steady state of cooling has been reached is usually about 5°F. It is sometimes less. Engineers should be encouraged to take fruit flesh temperatures during unloading and thus intensively study the peculiarities of individual holds and order their air distribution accordingly.

It would probably be of considerable value to place thermographs in lagged boxes in the centre of pens at some distance from the ship's thermometers. Such lagged thermographs should be interesting and instructive to the engineers and would definitely serve to show the rate of cooling of the fruit (as distinct from the air).

Alternatively, distant reading thermometers might be used.

The humidity of the air is a factor at present uncontrolled although it is a factor which is generally believed to have a profound effect on the storage life of the fruit. The humidity of the air could, by a very simple rearrangement of the existing cooling system, be modified at will and the effect of a lower humidity be tested. The use of an atmosphere of relative humidity 85 instead of the present 95 would undoubtedly check stalk-rot to some extent. It might also help slightly to check the rotting of damaged fingers and perhaps also the spread of spots.

It has already been mentioned that high humidities are believed to favour ripening but that no evidence has been found for this.

Since, however, it seems clear that no radically bad results can be expected from a reduction of humidity in the holds, while on general grounds good results are to be expected, it would seem advisable to make a definite trial of lower humidities in some holds.

At the same time it is clear that storage experiments on the effect of humidity upon ripening and fungal attack are needed to explore this subject thoroughly.

As regards atmospheric composition in the holds, the ventilation with fresh air practised is obviously sufficient to keep the carbon dioxide concentration below one per cent., for the carbon dioxide contents of some of the holds have been measured and found in certain instances to be .72, .7, .81, .37, .54, .29, 0 per cent.

There seems little doubt that if ripening during the voyage could be still further retarded than is at present possible with temperature control alone, the general quality of the fruit would be much improved. Fuller fruit could be shipped, less bruising incurred and "ships ripes" avoided. Experiments on the effects of reducing oxygen concentration are therefore being continued and if the successes already obtained are repeated, it would be desirable seriously to consider the application of atmospheric control in the holds. Preliminary trials should however first be made on a few hundred bunches in order to test out laboratory results under commercial transport conditions.

Secondly, there is stalk-rot. A method for the prevention of stalk-rot by treatment of the cut surface has already been mentioned. It now needs testing out on a commercial scale, under scientific control and observation.

Thirdly, there is spotting. Spotting badly needs further investigation. The complete control of the spread of spots is most probably not feasible. The initial invasions responsible for spotting must be prevented and the best methods of doing this can be determined only when it is discovered at what stage of development of the bunch, and under what combination of conditions spots originate. Some bunches escape and this fact should provide a clue to successful control. Only an investigation begun in the plantation and continued on ship board could provide this information.

Lastly, the solution of such pressing problems as the prevention of finger-rot, the control of stalk-rot, the prevention of fruit-rots, would then allow time for attention to such problems as the production of the very best colours and flavours, the prevention of bruising and the most effective means of ripening, problems which though of secondary interest under present conditions will undoubtedly become increasingly important.

V. Summary.

Bananas of a Cavendish variety are being regularly transported from Brazil to England with commercial success. The methods used are in the main similar to those used to transport West Indian bananas. Certain types of wastage are experienced in addition to the inevitable bruising. A stalk-rot is encountered similar in character to the stalk-rot encountered in Jamaican bananas, but neither so serious nor caused by the same fungus. It can probably be largely controlled by suitable treatment.

Finger-rotting follows mechanical damage and spotting rather than infection from the main stalk. Prevention of mechanical damage is always a difficult problem with Cavendish bananas but the fact that present shipments can be sold clearly indicates that damage need not be so great as to make their transport impossible. "Spotting" appears to be specific to Brazilian bananas. It is described as far as possible from the material available in England.

"Ships ripes" and "chilling" are also encountered. These can be overcome only by the fundamental studies in the temperature relation of bananas. Such studies are being conducted in Trinidad.

WEST INDIAN NOTES.

Compiled by the Advisory Department of the Imperial College of Tropical Agriculture.

Sea Island Cotton.

Two Conferences have recently been held in Great Britain at which Professor Ballou, the Commissioner of Agriculture was present to discuss the question of the disposal of the large stocks of Sea Island cotton now on hand. The question of finding new uses for this type of cotton was explored. The position is apparently even more difficult than it was a year ago, and the advice given to growers a few months ago to curtail the area under cotton was both sound and timely.

At the request of the Commissioner of Agriculture, the Empire Cotton Growing Corporation allowed Mr. S. H. Evelyn, the Cotton Officer stationed at St. Vincent, to make a comparative study of the conditions under which cotton is grown in St. Kitts and Montserrat. This officer also studied the methods in vogue at the St. Kitts' Government seed farm and the Montserrat Experiment Station for maintaining the standard of the cotton seed supply of the islands. In a report submitted to the Commissioner of Agriculture, Mr. Evelyn stressed the urgent need that exists for maintaining and developing the quality of the strain of cotton that is grown at the Experiment Station and the need for a better organisation to ensure that the growers obtain and plant only the best possible seed. This matter will receive the careful attention of the Agricultural Officers concerned.

Mr. Evelyn in his report also calls attention to the varying time of the year at which cotton is sown in the different islands *e.g.* St. Kitts and Montserrat, in February-March, whereas Nevis, Antigua, Barbados and St. Vincent all plant in August and September, usually the latter month. In the case of St. Vincent, the change of the planting season from February to September was fixed upon as recently as 1929 and has been claimed to prove entirely satisfactory. Mr. Evelyn has suggested that similar beneficial results would follow were a similar change made in the islands of St. Kitts and Montserrat. Whilst it is quite possible that from the cotton plant point of view Mr. Evelyn's view is the correct one, other factors have to be taken into consideration. For instance, in St. Kitts two major crops, sugar cane and cotton are reaped at the same season of the year, while in Montserrat, the effect of such a change on the development of the fresh vegetable industry with Canada would also have to be considered. Mr. Evelyn makes out a good case for the change of season from the point of view of insect pest control, and suggests that an identical close season for all the Islands would undoubtedly tend to the better control of pests.

The Sugar Industry.

Since the close of the 1931 sugar crop, which in most of the islands turned out to be extremely short, the weather conditions have been more favourable than for some time past, and the prospects for the 1932 crop are much more promising. The new varieties of sugar cane introduced by the Agricultural Departments in St. Kitts, Antigua and St. Lucia, are being propagated as rapidly as possible and will soon be available for experimental trial on estates.

Two steps have recently been taken in Antigua which it is confidently hoped will make for the permanent improvement of the sugar-cane agriculture of the island. The first was the inauguration of a Sugar Planters' Association, and the other the arrival in the island of a Gyrotiller, the first of its kind to be used in any of the British West Indies. Mr. Storey, the inventor of the Gyrotiller recently paid a visit to Antigua and saw this implement being tried. He also addressed the first meeting of the Association.

At the recent Imperial Sugar Conference a committee was formed to report on sugar cane research in the West Indies. This committee was assisted in its deliberations by two well known specialists Sir Rowland Biffen and Professor Engledow. Proposals were received and considered from the Governments of Jamaica, Trinidad, British Guiana and Barbados. Important recommendations made by the Conference included the continuation and extension of the work now going on in Barbados on the production of new varieties of sugar vane, and the establishing in Trinidad of a Plant Quarantine Station. The introduction of new varieties of sugar cane from other countries will be done through this station so as to minimise the danger of transporting diseases by means of planting material.

* * *

The Fresh Fruit and Vegetable Industry.

The following figures are now available of the quantities of fresh vegetables produced by the different islands during the 1931 season.

Islands.	*Tomatoes boxes.*	*Eggplants boxes.*	*Beans boxes.*	*Miscellaneous packages.*	*Total boxes.*
Montserrat	17,633	93	233	85	18,044
St. Kitts	4,630	12	51	173	4,866
Nevis	1,293	122	9	—	1,424
St. Lucia	44	—	—	6	50
Antigua	229	—	12	2	243
St. Vincent	1,652	—	—	58	1,710
Grenada	478	—	—	—	478
	25,959	227	305	324	26,815

From St. Lucia heavy shipments of seedling mangoes have been made to Bermuda and from most of the islands experimental shipments of grafted mangoes have been made to Canada and Great Britain. A shipment of grafted mangoes sent from Dominica arrived in London and was examined by Professor Ballou, who reported that they arrived in excellent condition. Given proper care in packing and the correct cold storage conditions on board steamer, there is no doubt that grafted Julie mangoes carry well. In addition to the shipments of green limes to New York, which is a long established industry in Dominica and more recently in St. Lucia, experimental shipments of limes have been made to Canada. The Canada-West Indies Produce Company has undertaken a vigorous campaign on behalf of this little known fruit in Montreal and other Canadian cities. Striking advertisements have appeared in the *Montreal Star* from which important results are anticipated.

In the September number of this Journal there appeared a description of a suitable lay-out for experiments in the growing of tomatoes. Varietal, manurial and cultural experiments were outlined and it is hoped that the Departments of Agriculture in the various Islands will be able to carry out such experiments in the near future. It may not be possible for all of them to undertake all the experiments indicated, but there is no reason why at least one of the experiments should not be undertaken. Little accurate information is available of the requirements of the tomato plant and before the Departments are in a position to advise with confidence they will require accurate information which can only be obtained as a resuts of carefully conducted experiments. In the early days of cotton growing in the West Indies, the Departments took a leading part in the establishment of the industry, they must now do their share in the establishment of this new promising industry.

* * *

Appointment of New Marketing Officer.

Mr. A. C. Shill, the newly appointed Marketing Officer for the Windward and Leeward Islands, proceeded after a stay of two weeks in Trinidad to Dominica *via* Grenada, St. Vincent, Barbados and St. Lucia. He will remain for some weeks in Dominica, where the fruit is now maturing and where fruit cleaning and sizing machinery have been installed. After making a tour of the other islands, Mr. Shill will return to St. Lucia where it is proposed that he should make his headquarters.

One of the questions that will engage the attention of the Marketing Officer at an early date, is the treatment that should be given to fruit and vegetables that have been kept in cold storage for some time awaiting the arrival of steamers and that will have to face exposure to high temperatures whilst being transported from shore to ship. Insulated containers have been suggested, but these would be both expensive and inconvenient to handle. Major Wheeler, the Fruit Transport specialist at Ottawa who visited these Islands earlier in the year has suggested that experiments be conducted to test the effect on the fruit by gradually warming it up before exposure and again subjecting it to cool temperatures. These experiments are being undertaken at the College and at St. Kitts, and Montserrat.

* * *

Blackheaded Persian Sheep.

This breed of sheep on which a note has already appeared in the January issue of the Journal is very popular in South Africa where it is found under widely divergent conditions. It is said to thrive well from Capetown in the extreme south, to Winbrock, West Africa, in the north, and Mombasa in East Africa. It is essentially a mutton breed and being short-haired is eminently suited to hot countries. The skins, which are in great demand, realise from 5*s*. to 6*s*. apiece. The quality of the mutton is excellent, the flesh being firm, tasty and tender. The whole carcass is covered with a layer of fat and the prominent tail is said to carry as much as 10 lb. of first quality fat and is prized by South African housewives. Though not as large as other breeds, pure bred Black Persians will scale from 100 to 110 lb. liveweight which would represent a killed clean weight of about 60 to 65 lb. The breed matures remarkably quickly and in South Africa lambs are sold at six months old, for about 15*s*. each. The lambing percentages are good and averages of three lambs per ewe in two years can be obtained. Black Persians, being very hardy, are practically immune to heartwater fever and blowfly, and with adequate grazing no artificial feeding is necessary.

With the exception of Jamaica, where Southdowns and Hampshires are kept, no serious attempt at sheep farming has been made in the West Indies. In Jamaica sheep are shorn twice a year instead of once as in temperate climates, the wool being marketed in Kingston. In other West Indian islands, sheep are not shorn and consequently do not thrive, the only sheep surviving, being those which are woolless or almost so. In Barbados, the common sheep are short haired, the top part of their bodies being usually coloured brown and the under parts black. The breed is probably of African origin and was introduced to Barbados by sailing ships bringing Senegal working oxen. Sir Daniel Morris, when Imperial Commissioner imported a few ram sheep of the woolless variety from Lagos in West Africa and their descendants from ewes of similar types found in Barbados, spread to the Grenadine Islands, and the Northern Islands especially.

A woolless sheep has recently been discovered in the West Indies possessing the good mutton qualities of English sheep, with none of the defects of the Lagos woolless sheep. These sheep were exhibited at the Zoological Park at Cincinatti, Ohio, in 1916 though not kept in the larger zoological parks in the United States of America.

The Blackheaded Persians would seem to offer great promise in the West Indies provided the foundation stock is healthy and has been reared under natural conditions. These sheep should be housed in pens with lathed floors to ensure proper drainage and dry feet. They should also be passed through a tray containing a thin layer of temper lime at the entrance to the pens. If this is done feet troubles should not be experienced, when sheep are grazed on plains or lowlands. With a little intelligent care and the adoption of the usual precautions and treatment against internal parasites which all shepherds have to contend with, there seems to be no reason why Blackheaded Persian sheep should not be successfully reared in the West Indies. Through the kind cooperation of Captain Metivier, of the Government Farm, Trinidad, the breed has now been introduced from Trinidad into St. Vincent, St. Kitts, Montserrat and Grenada.

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The Arrowroot Leaf Roller (*Calpodes ethilus*).

Mr. F. W. Urich who paid a short visit to St. Vincent with a view to studying the possibilities of the biological control of this pest, arrived at a time when many of the arrowroot fields in both the Leeward and Windward districts of the Island had been severely damaged. All stages of the butterfly were present in the fields though only in comparatively small numbers. There was, however, much evidence of the work of natural enemies. From information kindly supplied by the planters, it seems that the first wave of caterpillars which was a very severe one, started at the opening of the rainy season, towards the end of May and was over by the end of July. In August when Mr. Urich arrived, the second wave was in progress and the following parasites were collected :—

(*a*) two species of Tachinid flies, larvae of which issue from the pupa ;

(*b*) one species of an Eulophid hymenopterous parasite preying on half grown caterpillars ;

(*c*) one species of a Trichogrammid egg parasite ;

Tachinids appeared to have been very active ; the Eulophid parasites were not very numerous, although the egg parasites were much in evidence everywhere in the fields and were certainly keeping the pest in check. Several of the predaceous bugs found only occurred in small numbers in the fields. Harland recorded some parasites of the arrowroot leaf roller in 1916, but owing to the absence of collections for purposes of comparison, the parasites mentioned cannot be determined here.

Outbreaks of the arrowroot leaf roller, many of which have taken place quite suddenly, have varied a great deal in intensity. Opinions are divided among the planters of St. Vincent as to the extent of the damage done by the caterpillars, and some even go so far as to say that the yield of starch is hardly affected. The suddenness of attacks has also been a subject of discussion.*

* Williams, C. B. Records of Insect Migration in Tropical America, *Trans. Ent. Soc. of London*, July, 1920.

Harland is of opinion that the suddenness of the outbreaks is due to temporary lack of parasites, rather than to migration. Williams, on the other hand considers migration the cause of some sudden outbreaks. Whatever the causes may be, the present line of research should be aimed at a study of the parasite complex. For this purpose, the parasites occurring in St. Vincent, and those from other countries, will have to be studied, and in this connection Trinidad fortunately possesses several parasites of *Calpodes* which, after careful investigations, might be sent to St. Vincent. The butterfly is common in Trinidad and occasionally injurious to cultivated and wild cannas. Besides having parasites in common with St. Vincent, Trinidad has several others such as two species of egg parasites of one *Apanteles* species and one *Microbracon* species which both attack caterpillars ; there are also some Tachinids that may differ from those found in St. Vincent.

It is to be hoped that some means of biological control may be worked out, as spraying or dusting with arsenicals would be a very expensive and cumbersome method of disposing of the caterpillars. Poisoned bait for the butterflies might be attempted as another measure of control.

* * *

Miscellaneous Information.

Mr. S. H. Evelyn, Cotton Officer, stationed at St. Vincent, returned to St. Vincent on 20th July, having spent 10 days in St. Kitts and four weeks in Montserrat on official business.

Information has been received that owing to financial stringency the Governments of the Windward and Leeward Islands will not participate this year in any of the Canadian Exhibitions.

We are informed that a Prize Holdings competition, and an Agricultural Exhibition will be held in the Northern district of Dominica, where Mr. H. B. Pidduck is District Agricultural Officer.

Mr. F. W. Urich, Assistant Professor of Entomology paid official visits to Dominica and St. Vincent extending from 13th July to 18th August. In Dominica he investigated the fruit fly situation, and in St. Vincent the possibility of the biological control of the arrowroot leaf roller.

Mr. G. A. Jones, the Acting Commissioner of Agriculture, at the request of His Excellency the Acting Governor of the Windward Islands, paid a brief visit to St. Lucia to meet Sir Sydney Armitage-Smith, the Financial Adviser to the Secretary of State. Mr. Jones travelled by air from Trinidad on 1st August and returned by air on 4th August.

Mr. P. Morrison has been selected by the Secretary of State for the Colonies as Assistant Agricultural Officer in St. Vincent. Mr. Morrison is no stranger to the tropics, having occupied an important position on a large sugar estate in Trinidad. He arrived in Trinidad on 30th August and after a stay of about a month in Trinidad and Tobago, where he made a study of agricultural co-operation and credit, he proceeded to St. Vincent.

THE OPIUM POPPY.

By H. M. Leake, sc.d.

The Opium Poppy can hardly be considered a tropical crop. It is grown extensively in the Near East, where it has a dual value for, beside opium, the plant yields seed which is a source of oil in China and in India. In the last of these countries, though certain forms are grown in the cold weather on the Central Indian plateau round Malwa, the centre of production is the United Provinces where, again, it is found as a cold weather crop. The United Provinces form a tract in which the dominant agricultural feature is mixed cultivation on a basis of small holdings with an average size of under five acres. Though peasant proprietorship and tenancy both occur and are, in some cases intimately intermingled, the essential features of small holdings are common to both. The whole tract offers an illustration of that form of agriculture which is the basis on which agriculture must be conducted in those extensive tropical tracts which have a large indigenous population. Though, therefore, the crop is not a tropical one, the system under which it is grown is essentially tropical. It is this fact which must be my excuse for referring to a crop which has no claim to be considered tropical. The full story of the investigations into the opium poppy, in the conduct of which I played a minor part, has never been placed on record though it is some fifteen years since they were commenced. That story seems to offer some lessons pertinent to the problem of the development of agriculture under a system of small holdings the problem which, as stated, lies at the root of tropical agriculture.

One of the essential features of the opium crop of Northern India is that it is a crop grown for a cash return and it has, therefore, the features of an exchange culture in the strictest sense of the words. The fact that the product is a potent drug the sale of which is strictly controlled by Government introduces, however, certain novel features the bearing of which on the general problem is important and will appear later. Poppy is grown under licence and woe betide the cultivator who ventures to grow the crop without the necessary authority. The raising of the crop, and the extraction of the drug by lancing the immature capsules, is carried out by the cultivator. There is no free market for the product and administration, from the issue of the licence, to the collection and payment, for the drug is in the hands of a special department, the Opium Department. The officers of this department have an intimate knowledge of the country-side such as is possessed by few, for they pass from village to village, at one season issuing licences in person to the cultivators, at another receiving and weighing up the product again individually for each cultivator. They are, thus, brought into the closest contact with a host of cultivators and, further, there exists a record such as, for detail, exists for no other crop. By reference to the records it is possible to check, village by village, or field by field, both the area and outturn and, consequently, the effect of seasonal or other influences, throughout the tract.

About the year 1912 the Opium Department began to be seriously alarmed at the apparent increase of disease in the crop. Investigation proved the disease to result from two main causes, a Phytophthora, attacking the leaves and a Rhizoctonia which attacked the roots. The result of the mycological investigations is summed up by Butler, then Imperial Mycologist, in the following words:

"The investigation of this disease has led to the conclusion that while *Phytophthora arborescens* is a normal parasite present in almost every poppy field and probably, like most of its tribe, only epidemic under favourable climatic conditions for its spread, Rhizoctonia develops chiefly in fields in which the drainage is defective. The Economic Botanist, United Provinces has discovered certain varieties which appear to be almost immune to Phytophthora and in the growth of these and improved cultivation and drainage lies the best hope of preventing loss of crop."*

This summarizes accurately the position as it then presented itself and there is no doubt that the two fungi concerned were facultative parasites merely, present always but only becoming serious when the plant became weakened. There is no doubt, too, that the weakness of the plant was in some measure due to the causes noted. The apparent increase in the severity of the attack in the preceding years is to be explained by the fact that there was no free market for the product. The price fixed by the Opium Department was such as would, in the estimation of that Department, secure the necessary area under the crop. Like all fixed prices, it lacked flexibility and failed to respond to the general rise of prices that was then taking place in the case of the product of competitive crops. Under these conditions the cultivator was barely tempted to grow the crop and, when he did so, left it to inferior land and neglected cultivation. But, as later work was to show, an even more important cause of the predisposition to disease existed.

Even before these conclusions had been reached it was apparent for reasons which will be obvious to all who have experience of peasant proprietorship, that any direct attack on the fungus was out of the question and an indirect attack must be made. The readiest line for such an attack appeared to lie in the search for resistant varieties of which a seed supply could be built up for issue through the organization of the Opium Department. It needed only a casual inspection of the crop as commonly grown to show that this consisted of a heterogeneous collection of forms which offered reasonable prospect that one or more resistant strains would be forthcoming. The lot of attempting to effect this isolation fell

* *Report*, Agricultural Research Institute, Pusa, 1915-1916, p. 50.

upon myself and, through the willing help of officers of the Opium Department, a representative collection was made and grown at Cawnpore. In the ensuing crop the details of the methods of fertilization as well as the general characteristics of the crop were studied and a large series of selections made under conditions which would ensure self-fertilization. The knowledge so gained indicated the extent to which the poppy is cross-fertilized, thus corroborating Howard's * observations and the necessity of employing special precautions if purity was to be maintained.

While this work was in progress the War broke out and on the entry of Turkey into the War, the supply of opium for medicinal purposes was abruptly cut off. Medicinal opium has to conform to certain B.P. standards, of which the chief is a certain minimum morphine content. To this standard Indian opium did not conform and, in pre-war days, the medicinal trade drew its supplies from the Near East. In the face of this shortage, attention was directed to India and the question of the possibility of raising the morphine content of the Indian product became a pressing one. This problem was essentially chemical and the work of its solution was entrusted to Dr. H. E. Annett. Since abundant material was already available at Cawnpore, it was to that station that he was posted. Here, again, the preliminary idea was the isolation of a plant yielding an opium of high morphine content, and for success in this direction a preliminary investigation was necessary. Standard methods for the determination of morphine and other alkaloids in opium were inapplicable to the small quantities of opium obtained from single plants and it was desirable to devise, if possible, a method applicable to the product of a single capsule (some 0.025g.). It is not possible here to go into this aspect of the work in detail; with the termination of the War the urgent need for proceeding with the work vanished and, moreover, the solution of the problem was arrived at on other, and unexpected lines. But how far Dr. Annett was successful in his endeavour his many papers on the subject will indicate and I have in my possession a manuscript, which has never been published, summarizing his analyses of over 600 pure strains of opium poppy representing the forms grown in many countries. Not only do these show a wide range of morphine content, varying from six to twenty per cent., but there is evidence of a considerable seasonal variation in the morphine content of opium from single strains.

The main original objective of the work, the isolation of one or more disease resistant strains was, thus, by the march of events, subordinated to the more pressing question of morphine content. The solution of that question may be briefly noted here for, though it has little bearing on the subject of the present article, it is of more than passing interest, indicating as it does, how the unexpected so often materializes in work of this nature. To Dr. Annett belongs the credit of finding the solution. He found that, whereas the Indian cultivator lances the same capsule more than once, and sometimes as many as six times, and mixes the product of each lancing, in the near East lancing takes place only once. Acting on this suggestive difference, he determined the morphine content of successive lancings and found a progressive decrease from an amount which must be taken as characteristic of the strain, in the first lancing, to practically zero in the last lancing. He found further that practically all the races grown in the United Provinces from which the Opium Department drew their supplies, gave from the first and second lancings an opium which satisfied the B. P. requirement. The solution of the problem of raising the morphine content to the B. P. requirement was, thus, translated into an administrative one. It became a question of ensuring that the cultivator kept the product of his first two lancings separate from that of the later lancings; a question which, it may be said, was not free from difficulty.

If, as the above brief outline shows, the solution of one aspect of the problem was found in an unexpected direction, the solution of the other aspect, that of disease resistance, proved to lie in an equally unexpected direction. For the testing of disease resistance it is necessary to grow the plant under conditions which will normally give rise to the disease. Here the first difficulty arose. The entire range of poppies of United Provinces' origin, though raised from seed coming direct from cultivators' fields where disease was rife, proved practically free from disease. The fact that certain of the forms from sources outside the United Provinces were badly diseased was sufficient indication that the disease was present. In the absence of disease the selection of a disease resistant strain became a difficult problem. This freedom from disease, repeated from year to year, sufficiently indicated that the main cause must lie elsewhere than in the plant and, acting on this suggestion, the history of the plant, not only during the growing season but during the remainder of the twelve months, was passed under critical review. In that review only one difference at all likely to account for the observed facts was ascertained. Whereas the seed sown in the experimental work, whether derived from previous crops or direct from the cultivator, was secured at harvest, thoroughly dried and stored in an air-tight tin box or, when in larger bulk, in a concrete granary filled with dry bhusa (chopped straw) and bricked up and in either case left sealed up till the next sowing period; the seed used by the cultivator is merely enclosed in an earthen jar with the mouth sealed by clay put on moist. In the former case the seed comes from storage dry and in a condition to flow as readily as sand in an hour-glass; in the latter, protection against humidity during the rains is inadequate and it is frequently possible to insert

* *Memoir*, Department of Agriculture, India, Botany Series Vol. III, p. 321, 1910.

the hand into a jar of seed and withdraw festoons of seed matted together by the hyphae of a saprophytic fungus.

The importance of this difference will be appreciated when the conditions under which the crop is grown are explained. The crop is sown at the commencement of the cold weather on the moisture supplied by the preceding monsoon and no rain is to be expected normally for some two or more months. Under these conditions of falling moisture the seed has to germinate and the plant to establish itself. There is, thus, something in the nature of a race between penetration of the root and the descending level of adequate moisture supply. In this delicate balance sometimes one, and sometimes the other, wins. If the root wins the result is a strong and healthy plant capable of resisting disease whereas, if the moisture wins, a weak plant results, a prey to the first disease to come along. It is this difference in the robustness of the plant that determines whether disease will attack the crop and, though cultural conditions and drainage no doubt play their part, in the matter, it is in the quality of the seed that the main source of subsequent weakness lies.

The story may be anticipated here to indicate the magnitude of the difference for which adequate storage was responsible. When the first issues were made of adequately stored seed for trial in the cultivators' own fields, situated alongside other fields sown with ordinary seed, it was noticeable that germination in the former case took place some two days earlier than in the latter; a difference of considerable importance under the critical conditions indicated. Further, using the normal seed rate, namely eight pounds per acre, the crop was so thick that the extra labour required for thinning and weeding, and particularly the former, was given as a grievance by those cultivators entrusted with the adequately stored seed. This grievance, having as it did a certain humorous side which the cultivator was not slow to recognize, offered an easy remedy and subsequently a seed rate of four pounds per acre, or half the normal amount, was invariably adopted in the case of all stored seed.

It now became necessary to test out in practice the opinion which had been formed as to the advantage of adequate seed storage. For this purpose there was available at Cawnpore a large number of single plant cultures and, fortunately, the multiplication factor in the case of the poppy is very high. In the autumn of 1917 a pure strain, derived from a single plant in 1915, provided sufficient seed for twenty-eight acres and this was issued to the cultivators of a single village and no other seed was permitted to be sown in that area. Though these twenty-eight acres consisted of a number of small fields scattered throughout the village lands, the whole formed a compact and fairly isolated block.

The success of this preliminary trial, both as regards absence of disease and increase of yield, was such that it was decided to extend the scope of the experiment and a scheme was drawn up for the purpose. The ripened crop of this area was taken over, kept stacked for five days to ensure thorough drying out of the capsules and ripening off of the seed, the seed was then threshed out, bagged and stored, surrounded by dry bhusa, in a special concrete chamber the only opening to which, the door, was subsequently bricked up. The chamber itself remained closed till the time came to issue the seed for sowing. In this way some 8,856 lb. of well stored seed of the same pure strain was available for sowing in the autumn of 1918, and actually 1,337 acres were sown in three isolated blocks in the same manner as in the previous year. By 1921 the area had expanded to 6,025 acres, while six districts, some 20,000 cultivators and two additional strains were involved in the scheme.

By this time the scheme had expanded to so wide an area that appreciable differences of environmental conditions were involved and it was becoming apparent that a single strain would not adequately meet all requirements. A nursery was, therefore, established at Budaon where thirteen strains were tested out under rigid control involving the bagging of many thousands of heads to ensure the maintenance of purity. From these thirteen strains eight were selected for extended field trial under the same system of compact blocks as was adopted in the case of the original strain. Of these eight strains 20,350 lb. seed were collected at the harvest of 1924 while 55,350 lb. seed of the three earlier strains were also collected, the entire stock being stored in the manner already described. In the season 1924-1925, 19,504 acres were sown with this seed, the organization involving 56,640 cultivators, 1,500 villages and 13 districts.

That is the history of the development achieved through the organization of the seed supply; for, though two factors were involved, the employment of pure strains and the protection of the seed from harvest to sowing time, there is little doubt that the latter was the more important factor. From single plants the earliest of which was isolated in 1915, a crop covering nearly twenty thousand acres was grown and in that area disease had ceased to be a cause of anxiety and the seed rate had been reduced by one-half. The financial aspect of this work has not been published, but some idea of the financial gain which has resulted is given by a note in the *Annual Report* of the Agricultural Department of the United Provinces for the year 1922-1923. This reads as follows:—

"The increased production has yielded an actual nett profit to Government of 1.32 lakhs (1 lakh=£7,500) and over Rs. 49,000 to the cultivator in the last season alone—a profit which may be compared to the budget grant of under Rs. 40,000 for the work, while the area affected is but a tithe of the total area under poppy."

It need only be added that the cost as given above includes that of the investigations into the chemical aspect of the subject which were then

in progress. The Report of the Opium Department for the year 1924-1925 in like manner summarizes the position in the following words:—

"It has been conclusively proved that, if at any time a large increase in the outturn of opium should for any reason be necessary, it can be obtained by means of special seed, although naturally the result will not be obtained in the first year. The experiment has also had an educative value by proving to the cultivator the necessity of conserving his seed with care. If the work of the Opium Department has furthered the efforts of the Agricultural Department, the experiment may be regarded, apart from the value of the opium received, as having been worth the cost."

It is unfortunate for the further history of the scheme that it did not deal with one of the permanent crops of the country. If the scheme gained from the fact that the crop was under strict Governmental control, it suffered from the fact that the product formed the subject of international conventions. A great contraction has taken place in the area under poppy and the Opium Department is now but a shadow of its former self. Under these circumstances the need for an organized seed supply has departed.

Nevertheless, the experience is not without its lessons. It was a development carried out among a host of independent cultivators, widely scattered and growing on an average one-third acre each. It was carried out with a plant which is an annual and must be raised from seed each year; in which, further, cross-fertilization takes place to an extent which would lead to loss of type in a very few years were no precautions taken for the maintenance of purity. As far as the opium required for medicinal purposes was concerned, too, a question of quality of the product was involved. Both objectives were achieved and that success must be attributed to the intimate association with, and the personal knowledge of, the cultivators which were possessed by the officers of the Opium Department in whose hands lay the entire organization after the first issue of pure seed. To these officers it fell to select and check the fields to be set aside for further seed supply, to eliminate any chance aberrant plants in those fields, to harvest the crop and to arrange for storage. This is the problem that presents itself in all cases of peasant cultivation, but especially in those many cases in which purity of seed is reflected in quality in the product. Some organization having the same intimate contact with the individual cultivator appears to be essential to success in growing exchange cultures of this nature.

That is the conclusion to be drawn from the similarities existing between the poppy crop and exchange cultures in general. A further lesson can be derived from a comparison of the differences. Opium, being a dangerous drug, constitutes a Governmental monopoly and there is, therefore, no free market in it. It was this control of the market, and not merely the fact that the organization of the Opium Department was ready to hand, that was the essential factor to the success achieved. The price of the product, if not directly under the control of Government, was sufficiently so to leave a liberal margin which eliminated those financial risks which are inherent to competitive production. It does not follow, therefore, that the success here achieved by a Government Department will be repeated when production is for a competitive market. No Government has yet succeeded in entering a competitive market and it can never do so, partly owing to the lack of flexibility inherent in all Governmental financial systems; but, even more important, a consecutive policy can never be assured. Owing to that uncertainty, the entry of Government into any market is an infallible stimulant of instability. Of the truth of that fact there is ample evidence to hand in the varied attempts at Governmental control which have of recent years been made in so many countries. Yet the organization of the essentials for the maintenance of quality in the product, whether it be seed storage, maintenance of purity in the seed supply, or preparation of the product, to achieve its end must be in hands which are prepared, if they cannot control the market, at least to carry the risks which dealing in that market entails. It is a conclusion to ponder over, for a solution of the problem of the development of exchange cultures by a community of peasant proprietors will only be obtained when the implications of that conclusion are given due weight. That aspect of the subject cannot be entered into here: it has already formed the basis of a discussion in this journal.*

TEA IN INDIA.

Dr. Harold H. Mann's lecture, published in the *Journal of the Royal Society of Arts* upon the scientific aspects of the Indian tea industry, was an interesting historical resume, by one qualified to speak, of the progress in tea cultivation under Indian conditions. Dr. Mann went to India in 1900 as the first scientific officer of the Indian Tea Association. When tea plants were first cultivated in India, early in the nineteenth century, plants were introduced from China, but the discovery of indigenous tea plants on the borders of India and in Assam directed attention to the suitability of certain districts, especially Assam, for tea cultivation, and in 1839 the Assam Company was floated to take over and extend two-thirds of the Government plantation in the province. In those days, only Chinese experience and Chinese methods of cultivation were available, and Dr. Mann suggests that the Indian Industry has only thrived since it has been broken away from these methods and developed its own. Tea is a crop with special requirements; it thrives on acid soils and deteriorates upon liming; the crop required is not flower or fruit, but the young leaf; so that a special pruning and cropping technique is required in order to encourage the continual succession of young leafy shoots suitable for plucking.—(*Nature*, Vol. CXXVII, No. 3216.)

* *Tropical Agriculture*, Vol. VII, Nos. 8, 9, and 10.

TRINIDAD FODDER CROPS.

Digestive Trials of three Fodder Crops.

THE Chemical and Agricultural Division of the Imperial College of Tropical Agriculture have, with the co-operation of Captain Metivier, officer-in-charge of the Trinidad Government Farm, worked out the digestibility and nutritive value of three well known fodders:—Uba Cane (using the whole plant), Elephant Grass and Cane Tops (B.H. 10(12)).

Table I.—Analyses of three Fodders.

Fodder.	Moisture.	Crude Protein.	Ether Extract.	Crude Fibre.	Nitrogen Free Extract.	Ash.
Uba Cane (whole plant)	67.59	2.93	0.49	9.89	17.40	1.70
Elephant Grass	83.23	1.27	0.28	4.92	7.83	2.38
Cane Tops	72.38	1.32	0.49	9.28	14.86	1.67

Table II.—Digestibility of three Fodders.

Fodder.	Dry Matter.	Crude Protein.	Ether Extract.	Crude Fibre.	Nitrogen Free Extract.	Ash.
Uba Cane	60	56	43	58	66	30
Elephant Grass	59	64	45	62	61	43
Cane Tops	58	46	57	62	59	39

Table III.—Nutritive value of three Fodders (100 lb. samples).

Total Dry Matter.	Digestible Nutriments in lb.					
	Crude Protein.	Ether Extract.	Crude Fibre.	Nitrogen Free Extract.	Starch Equivalent.	Nutritive Ratio.
Uba Cane.						
32.4	1.64	0.21	5.7	11.5	15.5	1 : 10.8
Elephant Grass.						
16.68	0.8	0.13	3.05	4.8	7.15	1 : 10
Cane Tops.						
27.6	0.6	0.25	5.75	8.77	11.3	1 : 25

Table IV.—Comparison of Nutritive value of three Fodders.

Fodder.	Nutritive Value 100 lb.—in lb.		Starch Equivalent.	Nutritive Ratio.
	Total Dry Matter.	Digestible Crude Protein.		
Uba Cane	32.4	1.6	15.5	1 : 11
Elephant Grass	16.7	0.8	7.2	1 : 10
Cane Tops	27.6	0.6	11.3	1 : 25

Table V.—Average Daily Consumption of Nutriments.

(*a*) *Actual amounts in lb.*

Fodder.	Green Fodder.	Dry Matter.	Digestible Protein.	Starch Equivalent.
Uba Cane	37	12	0.6	5.7
Elephant Grass	114	19	0.9	8.2
Cane Tops	54	15	0.3	6.0
(*b*) *Calculated amounts for maintenance in lb.*				
Uba Cane	40	13	0.6	6.2
Elephant Grass	80	14	0.6	5.8
Cane Tops	55	15	0.3	6.0

Summary of the Results.

1. Elephant Grass is the most digestible; the chief differences between the three fodders is the digestibility of Crude Protein.

2. The Nutritive value of Uba Cane is almost double that of Elephant Grass, the Nutritive Ratio however being the same in the two cases. Cane Tops have a wider Nutritive Ratio which no doubt is due to non-digestibility of protein.

3. Elephant Grass appears to be more palatable then either of the two, as only in that case was the quantity eaten larger than that required to supply maintenance requirements.

4. Cane Tops though providing the lowest protein, showed most live weight increase during the trials, which indicates that not a large protein supply is required and that Cane Tops is not so badly balanced as it might appear.

5. Maintenance Ratios according to European Authorities are supplied by :—

40 lb. of Uba Cane.
80 to 85 lb. of Elephant Grass.
55 to 60 lb. of Cane Tops is the nearest approach with this fodder.

SUGAR NOTES.

Compiled by the College Department of Sugar Technology.

Economy in Evaporation and Heating. *W. E. Smith.*

A recent development in the design of heat-transfer apparatus that has greatly increased the capacity of the heating surface is the use of baffles on the steam side. In this way the velocity of the steam as it passes the tubes is kept up to the most effective rate of flow, sweeping before it the non-condensible gases which may then be effectively discharged from the end of the steam passage. In the case of juice-heaters the effect has been so marked as to make it possible to reduce the standard requirement to 20 square feet of h.s. per ton of cane per hour, as compared to 35 square feet without these baffles. Similar increases are claimed for evaporators so equipped, and rates of 12 lb. per square feet of h.s. have been claimed. Similarly, vacuum pans with baffled calandrias are coming into use but here in most cases the greater effectiveness of the h.s. is reflected in the ability to boil with lower steam pressures rather than in high rates of evaporating. Another successful development in vacuum pan design is the use of flat steam tube sheet calandrias of welded construction throughout, thus avoiding leaks at the rivetted joints between the centre wall casting and the inclined tube sheets. In these pans the tube sheets are of copper bearing steel $\frac{7}{8}$ inch thick, the centre well projecting below the bottom tube sheet to promote circulation in the cone of the pan bottom. No difficulty is experienced in bringing the massecuite up to any density desired, and stiff massecuites discharge freely without hanging upon the top tube sheet and besides there is a material saving in first cost to recommend it.

Probably the system of vapour utilisation at Honolulu Plantation as used for the past two years is the most complete of any in the cane sugar world. There a pre-evaporator furnishes vapour for the heating of raw juice and the re-heating of clarified juice. Then a second pre-evaporator furnishes vapour for the pan floor, and the entire boiling of low grades, raw sugar, and refined sugar is done with low pressure vapour. The vacuum equipment consists of four pans each with flat tube sheets and baffled calandrias with 1.9 square foot of h.s. for each cubic foot of pan volume. These pans operate with a maximum pressure of about 4 lb. Since the factory converts its entire crop into refined white sugar, the consumption of steam at the pans is practically double that of the raw sugar factory, and the saving in steam with this system is reflected in a material reduction of the extra fuel which was formerly necessary. At Hutchinson Plantation this year, raw juice will be heated in a primary heater with vapours from the 2nd cell, bringing up the juice temperature to about 185°F.; this juice will then pass through a 2nd heater, where it will be brought up to the boiling temperature by vapours from the 1st cell. To provide for the extra duty, the 1st cell will have a h.s. of 4,000 square feet, and the tubes will be eight feet long, the 2nd cell will have a h.s. of 3,500 square feet with the tubes seven feet long, while the 3rd and 4th cells will each have 2,500 square feet of h.s. with tubes five feet long. An interesting development is found in the multi-jet condenser, designed to operate without a vacuum pump the non-condensible gases being entrained with the water, and carried down the condenser water-leg. Recent improvements in design have reduced the water consumption of these condensers to the point where they equal the work of barometric condensers with vacuum pumps. In this design the injection water must be delivered to the nozzles of the condenser at a pressure of three to four lb. so that the power consumption of the water pump is practically equal to the combined requirements of both water and vacuum pump with the barometric condenser.—(*Int. Sugar Jr.* Vol. XXXIII, No. 392).

SUPPLEMENTS.

The following Supplements to the Journal can be obtained on application to the Editor:

1927 Sugar Supplement	..	1*s.*
Sugar Cost Accounts	..G. C. Skinner	1*s.*
Wilt Diseases of Coconut Palms.—(Parts I and II)	H. R. Briton-Jones	6*d.* each.
Giant Moth Borer of Sugar-Cane.. ..	..H. Martyn Skinner	6*d.*

THE LIVERPOOL COTTON MARKET.

II. The Spot Market.

By

R. G. Wood.

In a previous article* on the working of the Liverpool Cotton market it was pointed out that there were two distinct branches of the market, one dealing with Futures and the other with Spot or actual cotton. The previous article dealt mainly with the Futures Market; this one will deal with the market for actual cotton. In speaking of Spot cotton it is well to remember that this includes all sales of actual cotton, whether for immediate or forward delivery.

Unlike the Futures market where all contracts must be made in the official Rings during the stipulated hours of trading, there is no particular Exchange or Floor for Spot cotton and no special hours of trading; indeed if an actual sample of cotton were carried on to the floor of the Exchange it would cause a sensation. All Spot business takes place either in the selling room of the merchant or the buying room of the broker, with the telephone occasionally to facilitate matters. There are roughly two classes of Spot houses, the merchants or importers (who were formerly selling brokers) and the buying brokers. The merchant imports cotton and sells it to the buying broker who buys it for the spinner he represents. The merchant takes all the risks entailed, such as bad shipments (*i.e.*, cotton not according to sample or description) bad debts and bad trade. The buying broker takes no risk, but receives one-half per cent. commission (ten shillings—per £100) on the invoice price from the mill he represents. The mills, however, are satisfied that the commission they must pay the broker is money well spent by them. Should a merchant sell direct to a mill, he must according to the Association rules, charge the one-half per cent. to the mill. Naturally, the mill knowing that the commission has to be paid, prefers to buy its cotton through a broker who looks after the interests of the spinner and sees that the contract made is duly fulfilled in every detail.

The custom of the Trade in buying actual cotton is as follows: the mills inform their broker that they are in need of a certain quality of cotton. In order to get the largest possible selection to choose from, it being impossible in the time at his disposal to visit each merchant, the broker hands in a slip of paper to an official of the Association, who copies it, along with all other brokers' slips handed to him, on to one of several large black boards in the vestibule of the Exchange. For example these are a few of the items that may be seen any day:—

A.B.C.	D.E.F.
Memphis 3/16ths 50 to 100 on.	Strict Midd. Boweds.
Tokar 7*d.* to 7¼*d.*	Good Midd. ⅛ in. Texas.
Fine Sakel 7½*d.* to 8*d.*	Argentine 30 to 50 on.
Good Fair Uppers 40 on.	White Brazils 25 on.
Tanguis 75 to 100.	

G.H.I.	J.K.L.
Pima 6*d.* to 7*d.*	Amer. Seed. Scinde 10 off.
Sea Island 15*d.* to 20*d.*	Broach, Pars.
Memphis 1¼ to 1 5/16ths.	Oomra, 25 off.
	South African 50 on.

M.N.O.	P.Q.R.
Californian 80 to 120.	Staple Boweds 30 to 50 on.
Irrigated Texas 75 on.	Russian 50 to 70 on.
East African 150 on.	Full ⅛ in. Texas 75 to 85 on.

The sellers take a copy of all these orders and send in samples or "selling papers" of any cotton they have on hand which they think will suit the buyers. A complete selling paper generally contains samples, weighing four ounces each, taken from 16 different bales upon which the merchant is willing to sell up to any quantity required. (In case of a line of 500 to 1,000 bales three or four papers are shown and these become the samples upon which the cotton is bought). The samples are usually sent over to the brokers before 10.30 a.m. where the broker examines each paper most carefully, retaining the best for further inspection. Later in the morning the spinner himself may arrive and he and his broker examine those that have been "kept on" and make their choice together. They then get in touch with the seller and the bargaining begins. They already know the "basis" (or number of "points on" of "off" Middling) the seller is willing to take, as this is sent along with the sample, so they bid him so many points less. The seller is aware that if he is too dear the broker will bid for the lot he likes next best, and it frequently happens that if the first man is too dear the second gets the business, so it is not often the first man lets go his chance. Ultimately, often after tremendous wrangling, the basis is agreed upon and the transaction completed. The deal being done, official contract forms, containing all particulars of marks, quality, quantity, delivery and "basis," are exchanged between buyer and seller. The broker is responsible to the mill he represents to see that the terms of the contract are carried out in every detail.

When the mill wishes to take delivery of the cotton, the broker sends in a sampling order and each bale is sampled by number in the warehouse. These samples are taken to the buying room and

* The Liverpool Cotton Market. *Tropical Agriculture.* Vol. VIII. No. 8.

compared with the original sample now known as the "buying paper." Any bales that are not equal to the buying paper either in staple or grade, are exchanged with the seller's consent, until the quantity bought is complete and duly forwarded to the mill.

In the case of Egyptian and East Indian cotton the sample taken from one bale represents 10 bales. Egyptian cotton is so regular in quality that it is safe to say a bale taken at random represents ten of its brothers, whereas East Indian is so hard and cakey that the time taken in sampling each bale would considerably increase the purchase price.

It often happens that, notwithstanding the care taken by the broker to see that each bale forwarded is well up to the buying paper, bales when opened at the mill turn out to be inferior either in staple or grade or both. If a bale is what is known as false-packed in staple, that is, containing different lengths of staple, it can be returned by the mill and replaced, but on no other condition will a bale be taken back by the merchant once it has passed the scale on being delivered from his warehouse.

Naturally the weight of the bands and canvas is deducted before the cotton is invoiced. The broker collects the invoice, to which he adds one-half per cent. of the invoice amount and the forwarding charges, posts it to his mill and in due course receives and pays the proceeds to the seller. Spot cotton is usually sold for payment in ten days from the invoice date, though in any case where the financial standing of the mill is not too good, cash before delivery can be demanded.

Each day an estimate of the total sales is made by an Association official, who visits all the brokers, ascertaining from them the amount of Spot cotton they expect to buy for their mills. At the end of each week a correct return is made by the merchants as to the amount of cotton they have sold during the week, and these figures can be compared with the estimated sales. It seldom happens that they quite agree. There is an Association custom that when these two figures actually agree the official who estimates the sales is presented with a pair of white gloves. During the writer's 25 years experience only two pairs of gloves have been presented. The actual sales during the last 12 months have averaged about 4,000 bales per day against an average of 6,000 to 7,000 in pre-war days.

The existing method of the purchase and sale of cotton is by no means perfect, yet it is as good as conditions will allow. In the main, allowing for the infinite variety of the quality of cotton and the vagaries of human judgment, the best cotton is bought at its lowest basis.

In conclusion a word or two about price and "basis". Cotton is seldom bought and sold at a fixed price, though in Manchester yarn and cloth always are. Each quality of cotton has its relative basis, that is, points either on or off the price of Futures. The penny in the cotton trade is divided into one-hundredth parts, called points. One point (1/100th part of a penny) is equal to £2 sterling on 100 bales of 480 lb. nett weight. For example if the Futures price of American cotton for July delivery to-day is 4.60*d*. per lb. and cotton is bought say on the basis of 60 points on, then if the price were fixed at once the invoice price would be 5.20*d*. per lb. (60 points on 4.60*d*.). The Futures contract calls for a certain quality of American cotton, *i.e.*, Middling in grade, Boweds quality, which is cotton grown in Alabama and Georgia, of not less than fair staple which means about one inch in staple and very regular. There are nine official American grades of which Middling is the middle. These below are at a discount while those above command a premium. Length of staple alters the value of cotton, the longer generally being the dearest.

The value to a spinner of being able to buy his cotton "on call," at so many points on or off the price of a future month is considerable. It means that however much prices may move, he can secure his quality at a certain basis for immediate or future delivery and can with confidence run his mill for months ahead. Basis does vary but very little in comparison with price. If in May he wishes to buy his quality for July delivery and the price of July is quoted say at 4.75*d*. he can make sure of his quality at 65 points "on call" on July. When July comes the price of Futures may have risen to 5.50 or 75 points higher, but as he never fixes his cotton until he has sold his yarn, variation in price makes no difference to him as yarn and cloth prices keep in relation to the price of cotton. If in May, with cotton at 4.75*d*., it costs him 5*d*. a lb. to turn the raw cotton into yarn, his price for the yarn would be 9.75*d*. but the same would apply in July when cotton being at 5.50 his yarn price would be 10.50. The spinner has the privilege of calling or fixing his cotton at any time up to the last day but one of the month for which the cotton has been bought. The system of hedging which permits of cotton being sold on call is of incalculable value to the whole cotton trade, and spinners owe much to the foresight of the merchants in the past who evolved this sytem. Of course the spinner could get practically the same result by buying the cotton he wants immediately, and selling a hedge against it to cover himself against a fall in the market; but that would not only require large capital and storage accommodation, but it would also mean paying double commission, once on the actual contract and again on his hedge contract. The merchant must of course protect himself with a hedge when he sells on call (the cotton will already be hedged when he imported it) but he being a member of the Association pays no commission.

THE subscription to *Tropical Agriculture* is six shillings per annum, post free, Trinidad currency, to all countries within the British Empire or seven shillings and six pence, post free, Trinidad currency, to all other countries. Subscriptions can commence at any time during the year.

THE IMPERIAL MYCOLOGICAL INSTITUTE.

[*The following article is reproduced from "The Times." We are indebted to the Empire Marketing Board for the photographs which appear on the opposite page.*—ED.]

THE science of mycology which devotes itself to fungi, is one of the newest and most rapidly growing branches of biology. An important step forward has just been made. The new headquarters of the Imperial Mycological Institute (until recently known as the Imperial Bureau of Mycology), erected with the aid of a substantial grant from the Empire Marketing Board, have been completed and occupied. The bureau was founded in 1920 and is supported jointly by the Dominions, Colonies, and the Home Country, under the management of a committee of which Lord Buxton is the chairman. It has two main functions. One is to identify and describe specimens of fungi sent in by field workers from all over the Empire, and, if necessary, to advise on control measures. The other is to act as a clearing-house of information for all matters relating to plant diseases, other than those caused by insects. Its object is to distil research results coming in from every part of the world, in all languages, and to pass on the essence to oversea workers by way of a monthly journal, the *Review of Applied Mycology*, containing abstracts and translations of all papers published on relevant subjects throughout the world. The new building, made necessary by the rapid expansion of the work, stands on Kew Green and has been designed to harmonize perfectly with its famous Georgian surroundings. The only external clue to its real purpose is a frieze of toadstools over the windows, which have been copied closely from scientific drawings.

Some idea of the losses inflicted by fungi on growing crops can be obtained from estimates such as those made for rust damage by the Canadian Department of Agriculture. In 1916 black rust destroyed about £35,000,000 of wheat in the three Prairie Provinces. It averages about £5,000,000 worth of damage a year; while smut costs Ontario alone nearly £1,000,000 a year. The annual loss caused by fungous diseases of crops and vegetables in Australia is estimated at 15 per cent. of the total output, or £7,000,000. The same mournful story can be told of practically every other Dominion and Colony. In New Zealand total losses to cereal and root crops in 1924-25 amounted to some £2,220,000. Worse still, the loss is not always to be reckoned in terms of money.

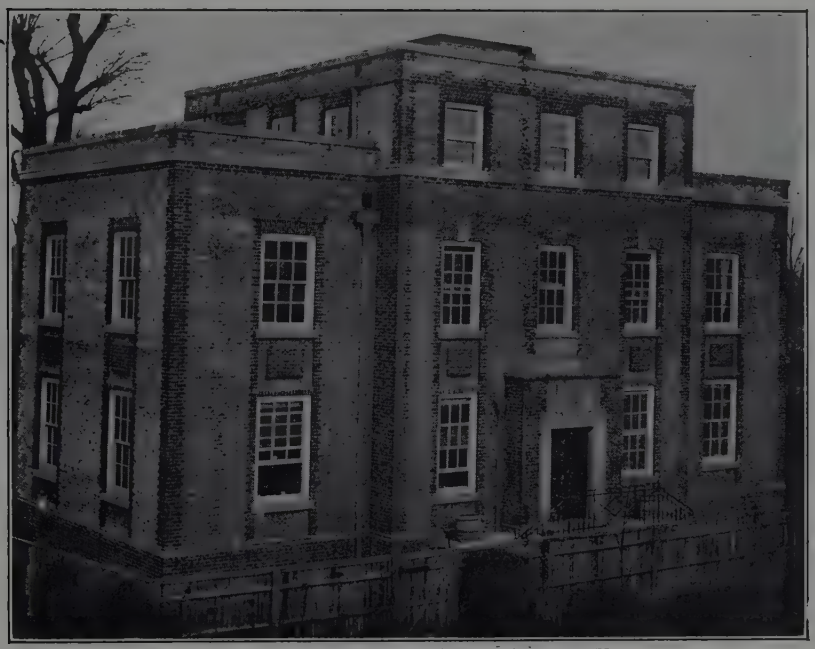
Disraeli was not exaggerating when he wrote in "Endymion" that "the mysterious malady of a single tuber changed the political history of the world." Now scientists have brought potato blight under control, and the risk of a repitition of a disaster such as the Irish outbreak has gone. But elsewhere science is only beginning to feel its way, and the risk remains a very real one. Coffee-leaf disease in Ceylon not only cost the island £12,000,000 to £15,000,000 by its appearance in 1868, but led to the abandonment of coffee cultivation. In Dominica withertip of limes, first seen there in 1922, reduced the crop on many estates by 90 per cent., and the very existence of the industry is now threatened. Panama disease of bananas, which first appeared on the Isthmus about 1906, has led to the abandonment of thousands of acres of plantations in Central America and is now spreading in Jamaica. Insect plagues, violent as they often are, have probably never led to more devastating or costly results.

In spite of the magnitude of these problems, they have received serious attention only in comparatively recent times. The pioneer work in England was done in the middle of the last century by a clergyman, the Rev. M. J. Berkeley, who became known as the "Father of British Mycology." Official recognition of the new science came first in 1880, when an investigator was sent by the Colonial Office to Ceylon to study the *Hemileia* leaf disease, and, seven years later, the late Sir Arthur Shipley was sent on a special mission to investigate an onion disease in Bermuda. The first Government appointment of a permanent mycological officer, however, was made by Australia in 1890, when Mr. Daniel McAlpine, who studied biology under Huxley, was made Vegetable Pathologist to the Department of Agriculture at Victoria. Almost simultaneously a similar post was created in New South Wales, and these two men were the only Government mycologists working in the oversea Empire at the beginning of this century. To-day, so quickly has the science developed, there are over 100, and their number is increasing yearly.

The rapid accumulation of data made necessary an organization such as the Mycological Institute for co-ordination of research. Dr. E. J. Butler, F.R.S., and his staff have no light task. Thousands of species are still unstudied and even unnamed, and the problem of correct identification and nomenclature presents many difficulties. A book on Indian fungi, which is shortly to appear, enumerates 2,400 species, and yet this is probably not more than one-tenth of the total number of fungi in India. Hardly a day passes without the arrival at Kew of a carefully packed test-tube containing a fungus which has baffled mycologists in its native land, accompanied by an urgent appeal for help. Here is a typical week's "bag":—

> An unknown fungus found attacking maize in Barbados; ten fungi, only half of them tentatively identified, from Ceylon; one specimen found on cassava root near Nairobi; another suspected of causing premature dropping of coconuts in the Seychelles; two parasites found on sugar-cane in Mauritius; and several members of the huge group of soil fungi from India.

THE IMPERIAL MYCOLOGICAL INSTITUTE.



The new Headquarters of the Institute at Kew.

Interior view of one of the Laboratories.

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All these specimens must be inoculated into an artificial medium such as agar-agar (a Japanese seaweed) or beef jelly, and cultivated in incubators. It has been discovered at the Institute that fungi share with racehorses a liking for oats, and specimens that could not be persuaded to grow on ordinary media have thrived on a dish of crushed oats. Their growth is microscopically examined and they are, if possible, allocated to some previously described species. Their collector is then furnished with a *dossier* of all that is known up to date of the species and of the disease for which it is responsible.

Correct identification of fungi is essential to an understanding of their habits. It was recently found, for instance, that the same kinds will prey on butter and on copra—two seemingly diverse products, but both containing the same type of fat. Lately the Institute has received an increasing number of inquiries regarding these moulds on stored products, especially butter, probably owing to recent legislation forbidding the use of all preservatives. The New Zealand Government has sent a worker to make a special study of this group at the Empire Marketing Board's Stored Products Research Laboratory at Slough with a view to tackling this important problem at the production end. Some of these moulds are remarkable in that they continue growth below freezing point, and one, from Gold Coast cocoa, grew best at the Institute at the torrid heat of 122 °F.

Trees and timber are particularly susceptible to fungal attack, and one interesting piece of teamwork completed recently between British and Canadian workers has been largely successful in removing a source of trouble in the manufacture of aeroplanes. Sitka spruce from British Columbia is used extensively for the construction of propellers and other wooden parts of aeroplanes. It has, of course, to undergo very severe tests, and a surprisingly large percentage of apparently unblemished timber was at one time found to break down. No sign of fungal infection could at first be seen; but examination at the Institute under a microscope revealed the minute tentacles of a fungus. A Canadian woman worker took up the problem, travelled through the British Columbian forests, and discovered the source of infection on the unfelled timber. Cooperative work between the Forest Products Research Laboratory at Prince's Risborough and its opposite number in Canada showed, further, that the disease was accentuated by the long voyage through the tropics *via* the Panama Canal. The trouble has been largely eliminated by careful examination of trees before they are cut and by overland transport.

A new aspect of mycology is the control of insect pests by fungous parasites. This is only likely to be successful under certain well-defined conditions—probably only in tropical islands—but the Institute has recently had one encouraging success with this method of "biological control". A scale insect which was introduced into the Seychelles about ten years ago, and which now attacks coconuts, was found to be free from a fungus usually associated with it in other parts of the world. This parasite was collected from scale insects in Sierra Leone and despatched to the Seychelles. Efforts to establish it in the islands apparently failed, and it disappeared. Quite recently, however, epidemic outbreaks were found—presumably resulting from descendants of the Sierra Leone immigrants which had survived unnoticed. Now, at any rate, they are spreading rapidly, and it is hoped that they may succeed in bringing under control this particular insect pest of the coconut crop.

A highly important aspect of the Institute's work from the standpoint of future production in the Empire is its study of quarantine regulations and legislation on plant diseases. For economic mycology is not, by any means, only a question of repairing the harm when it is done. One of its biggest problems is to prevent diseases from spreading in the future, as they have in the past, to countries hitherto free from their ravages. The cocoa industry provides an example of the existing situation. Some years ago the dreaded Witch Broom Disease wiped out the plantations of Ecuador, where a particularly fine grade of cocoa—Essequibo—was produced. It has since spread to the Caribbean and is now gaining ground in Trinidad. But West Africa, so far, is free. Should the disease reach the Gold Coast, where half the world's supply of cocoa is produced, the effect would be swift and devastating.

Vigorous quarantine regulations are enforced in the British Colonies. But a fungus spore is smaller than the tiniest grass seed, and one of them might ruin an industry. Clearly a stowaway of such lilliputian size might slip through the stoutest barrier that human ingenuity could devise. It is against situations such as these that the mycologist, working against time with insufficient data and wide gaps in his knowledge, must be continually on the alert.

COLONIAL APPOINTMENTS.

The following appointments, transfers and promotions have been made during the months of June and July, 1931, by the Secretary of State for the Colonies :—

Mr. G. F. Clay (Senior Agricultural Officer, Uganda), Deputy Director of Agriculture, Uganda.

Mr. A. C. Miles (Provincial Superintendent of Agriculture, Gold Coast), Assistant Director of Agriculture, Gold Coast.

Mr. A. J. W. Hornby (Agricultural Chemist, Nyasaland), Assistant Director of Agriculture, Nyasaland.

Mr. W. T. O. Maidment (Assitant Superintendent of Agriculture, Gold Coast), Agricultural Officer, Uganda.

Mr. J. de Verteuil (Agricultural Chemist), Trinidad, Agronomist, Trinidad.

CHEMICAL NOTES.

Compiled by the College Department of Chemistry and Soil Science.

Wood Preservation under Tropical Conditions.

An interesting communication entitled "Progress in Wood Preservation" from the "Laboratorium für Holzkonservierung" of Berlin is published in a recent issue of *The Industrial Chemist*. A summary of the communication is given below.

As a result of extensive research in the laboratory and field, various inexpensive water-soluble salts or salt compositions, which are highly toxic and non-corrosive, have been prepared for the preservation of wood. Certain of these have been shown to be very satisfactory for ordinary requirements under normal European conditions, but in tropical climates, where the life of timber is shortened by the attacks of wood-destroying insects and by exceptionally heavy rainfall, these preparations have not proved entirely suitable. It has been the aim of the wood impregnation industry to discover a salt which is not washed out of wood. For this purpose the toxic substance must not only penetrate freely into the wood, but it must also undergo some process of fixation without losing its fungicidal and insecticidal properties.

According to Wehmer (1912) and Elfving (1918-19) wood-destroying fungi secrete acids during their life. Upon this discovery the Z.M.A. process for preserving wood of the Curtin-Howe Corporation of America is based. In this process the wood is treated with a solution of zinc acetate and arsenious acid with the addition of a given quantity of acetic acid. On drying, the treated wood loses acetic acid by evaporation. In consequence of this loss the water-insoluble salt zinc meta-arsenite is precipitated. The acid secreted by fungi in the wood redissolve the salt and are destroyed by it. A series of articles by Curtin and Howe in the *Journal of Industrial and Engineering Chemistry* (1927-28) give fuller details of the process.

In view of the possibilities to which such a process give rise, further investigations were undertaken in the "Laboratorium für Holzkonservierung". The results obtained were published by Wolman and Pflug in the *Journal of Industrial and Engineering Chemistry* in July, 1929. According to these workers the principle of the process, *i.e.*, the precipitation of a water-insoluble but acid-soluble substance in the wood, appears to be well founded, and is of fundamental importance in the treatment of wood with salts. On the other hand, Wolman and Pflug doubt whether the process described affords a practical solution to the problem. It appears that the solutions used in the Curtin treatment are liable to chemical change, and in general cannot be heated up to a temperature of 35° to 40°C. without decomposition. Further, it seems that the precipitation of zinc meta-arsenite within the wood is largely prevented, possibly because evaporation of the acetic acid from the wood on drying is incomplete. Even when subjected to leaching of a non-exhaustive nature, wood treated by the Curtin method may lose much zinc and arsenic. This can only be explained by the absence of precipitated zinc meta-arsenite in large amount.

The communication states that as a result of several years research by the "Laboratorium für Holzkonservierung" a salt composition has been prepared which meets more adequately the requirements of tropical conditions. The composition is known as "Thanalith-U". It is a solid, non-hygroscopic yellow powder which is sufficiently soluble to form a 6 per cent. solution in water. The existence of such a substance in the solid rather than liquid form is obviously of great advantage. It contains salts of fluorine and arsenic, and also salts of nitro-derivatives of phenols. It is said to possess no properties which prejudice its use as a wood preservative.

For the treatment of wood a 2 per cent. solution of "Thanalith-U" is recommended. A solution of this strength can be made without difficulty by dissolving the substance in hot water. The solution is of a reddish colour and possesses a weakly alkaline reaction. It does not attack iron even at temperatures of 70° to 80°C. The solution may be heated to boiling point without decomposition. The treatment of wood should take place at 80°C.

In the preparation of "Thanalith-U" it has not been considered advisable to concentrate on minimum leachability. On the contrary, the composition has components which are to some extent removable by water. These components are available to preserve treated wood from fungi and mould during its first years of service, without being dissolved by fungus secretions.—(*Industrial Chemist*, July, 1931.)

RICE RESEARCH IN INDIA.

THE Empire Marketing Board has made a grant of £15,790 (Rs. 203,279) spread over five years, towards a scheme for the development of rice research in India which aims at increasing the yield and improving the quality of Indian rice.

The scheme is organised by the Imperial Council of Agricultural Research of the Government of India. The Empire Marketing Board has offered to bear half the cost of developments in Burma, the principal rice exporting Province, and Bengal, where Patna rice is grown for export. Schemes for development of research in the remaining five Provinces are to be financed entirely by the Imperial Council.

The area under rice in India is nearly half as much again as the whole area of the United Kingdom. About 33,000,000 tons are produced annually of which only a small proportion is exported. The United Kingdom imports about £1,790,000 worth of rice annually from all sources. The scope for research is immense. Improvement may come through breeding better varieties of rice already grown in India, or through establishing there new and better kinds of rice from other countries.

REVIEWS.

Co-operation in Danish Agriculture.

By Harald Faber. An English adaptation of "Andelsbevoegelsen I Danmark", by H. Hertel. *Longmans, Green and Co.*, pp. 188.

This book was originally published in 1918. Essentially the information which it contains is the same as that in the first edition, but Mr. Faber has brought it up to date with the help of more recent official statistical publications, and of a book dealing with co-operation published in 1929 by the Danish Central Co-operative Committee.

The present edition remains a remarkably concise account of the co-operative movement in Denmark. It is in effect, a short history of the development of modern Danish agriculture. It shows quite clearly that the present system of co-operation in Denmark owes much of its success to an equally efficient system of education. The co-operative organisation is now so complete that it can be traced link by link to its keystone, the Danish Central Co-operative Committee, a body representing the whole movement in the country. Its foundations, however, are the local societies which aim almost exclusively at the improvement of agriculture and agricultural industry.

The book which records the development of the various societies, their difficulties and struggles and the measure of success which they eventually achieved, is a welcome addition to the literature on agricultural co-operation.

G. G.

* * *

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This bulletin has been issued recently by Messrs. Baird and Tatlock, Ltd., with the object of bringing new scientific apparatus to the notice of laboratory workers. The first number is devoted to some applications for the Thermionic valve and it is intended that each subsequent issue will deal exclusively with a single rapidly developing subject. The bulletin, which is well illustrated, is to be recommended to all those who want to keep in touch with recent advances made in new scientific apparatus.

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NEW LIBRARY ACCESSIONS.

AGRICULTURE.

Garratt, A. N. Organisation of Farming, 6*s.* *Messrs. Heffer & Sons*, Cambridge, 1930.

Powell, H. Clark. Culture of the Orange and Allied Fruits, 21*s.* 6*d.* *Central News Agency*, South Africa. 1930.

Saunders, A. R. Maize in South Africa, 21*s.* *Central News Agency*, South Africa. 1930.

Tracey, Will. W. Tomato Culture, 5*s.* 2½*d.* *Orange Judd.*, New York. 1929.

Walters and King. Animal Husbandry, 7*s.* 6*d.* *Messrs. Ginn & Co.*, 1930.

CHEMISTRY.

Baker, J. W. Natural Terpenes, 6*s.* *Messrs. Methuen & Co.*, 1930.

Fagg and Hutchinson. Regional Surveying, 7*s.* 6*d.* *Cambridge University Press*, 1930.

Findlay, A. The Spirit of Chemistry, 10*s.* 6*d.* *Messrs. Longmans, Green*, 1930.

Findlay, A. Practical Chemistry, 7*s.* 6*d.* *Messrs. Longmans, Green*, 1931.

Gray, A. N. Phosphates and Superphosphates, 8*s.* *International Superphosphates Manufacturers Association*, 1930.

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TREND OF THE MARKETS.

[*The notes below are based principally upon running charts of the prices of the basic grades and upon general statistical information gleaned from contemporary publications and cablegrams and are intended to be a record of movements. An attempt is made, where possible, to indicate the market outlook at the time of going to press, but no responsibility for the accuracy and subsequent truth of such observations is assumed. Unless otherwise stated the prices quoted are spot, London.*]

SUGAR.—Prices on the Home Market have ranged as follows: (c.i.f. per cwt.) :—

	Foreign.	*Preferential.*
	s. d.	*s. d.*
30th July ..	6 5¼	10 3
7th August ..	6 5¼	10 2¼
13th August ..	6 3	10 0
20th August ..	5 10½	9 7½
27th August ..	5 10½	9 7½
3rd September ..	5 8½	9 4½
10th September ..	5 7½	9 4½

Messrs. C. Czarnikow Ltd. report that the steadiness witnessed in Sugar markets during the past few weeks has recently given place to a more subdued feeling, values generally experiencing a set back. Quite apart from the disturbed economic situation and the depressing atmosphere created by recent market movements in other staple commodities, the continued unrest in Cuba has contributed in some measure to the unsettling influence in the markets. Is has also been suggested that Java may give more attention to European outlets and having regard to the disappointing shipments to British India, this development is naturally one to be reckoned with in future calculations.

* * *

COCOA.—Since last writing there is little to report in regard to the cocoa market. As far as Accra is concerned the continued pressure of Bahia has greatly forced prices down in New York and the London market has, to some extent, moved in sympathy. The price for this grade may be quoted at 23*s.* 9*d.*, *c.i.f.* Locally there is very little offering and between $5.50 and $5.80 a fanega is quoted.—(*By courtesy of the Cocoa Planters' Association of Trinidad, Ltd.*)

* * *

COFFEE.—Sales per cwt. of quality coffee have recently included pale and secondary Jamaica at 110*s.*, of secondary Costa Rica at 100*s.* of fine Nicaragua at 120*s.* Uganda Robusta is at 35*s.* or 10*s.* under the price of Brazilian; fair Kenya at 73*s.* 9*d.*, seconds at 65*s.*, and small at 45*s.* a cwt.—(*Times Trade and Eng. Supp.*, 22nd August.)

* * *

TEA.—Latest averages include Ceylon, 13.50*d.*, Indian, 8.46*d.*; and Java 6.39*d.* With the new season's sales prices have on the whole shown an upward trend. London stocks as they presently stand show that the market has vanquished its leading difficulty of an undue spot accumulation of warehoused tea.—(*Times, Trade and Eng. Supp.*, 22nd August.)

RUBBER.—Quotations for Plantation Sheet have ranged as follows :—

	d.
29th July	$2\frac{3}{4}$
5th August	$2\frac{9}{16}$
12th August	$2\frac{7}{16}$
19th August	$2\frac{5}{16}$
26th August	$2\frac{3}{8}$
2nd September	$2\frac{1}{2}$
9th September	$2\frac{3}{8}$

A new low record was created on 19th August, when business on the Spot was done at $2\frac{5}{16}d.$ The active cause of the fall in prices was the sharp break in cotton prices as many holders of cotton are also holders of rubber and losses in one article are not unnaturally reflected in the other. The question as to whether or not the Dutch Government will propose to the British Government some joint form of restriction of output or of shipments, will probably be settled within the next two months.

* * *

COTTON.—The following are the official Spot prices in pence per lb. of the Liverpool Cotton Association :—

	American Mid.	*Egyptian F.G.F. Sakel.*	*Sea Island.*		
			Good.	*Extra fine.*	*Prices paid this Week.*
31st July	4·62	6·95	15·00	30·00	14·75-15·25
7th Aug.	4·29	6·55	15·00	30·00	—
14th Aug.	3·80	5·75	15·00	30·00	—
21st Aug.	3·70	—	15·00	30·00	
27th Aug.	3·86	—	15·00	30·00	—
3rd Sept.	3·73	—	15·00	30·00	—
10th Sept. .... (local)	3,80	—	15·00	30·00	—

A sharp break in cotton prices occurred in the third week of August which was brought about by the publication of the Bureau's estimate of a crop of 15½ million bales as against a previous estimate of about 14 million bales. Sea Island has been neglected and there are no quotable changes in price.

* * *

LIME PRODUCTS.—*Lime Oil.*—Handpressed remains firm with small demand. Distilled, small arrivals have sold again at 38*s.* *Lime Juice.*—No improvement in the demand for concentrated and sellers still at £4. Raw is quiet and unchanged.—(*West India Committee Circular*, 20th August.)

* * *

DESICCATED COCO-NUT.—The market is steadier. Quotations 18*s.* 6*d.* spot, August to September. 16*s.* 6*d.*, September to October 16*s.* 6*d.*—(*West India Committee Circular*, 20th August.)

* * *

ARROWROOT.—There is no change to report, prices remaining at sellers, 3½*d.* per lb. for fair manufacturing; 4½ to 5½ for grocery; and 8*d.* to 10*d.* for druggists.—(*West India Committee Circular*, 20th August.)